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Machinery.

ENGINEERING EDITION.

Index to Vol. X.

September, 1903, to August, 1904.

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1904.

THE INDUSTRIAL PRESS.
66 WEST BROADWAY.
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 (4) Diagram of Diameters and Speeds.
JUNE: (1) Chain End Link and Narrow Shackle.
 (2) Proportions of Keys.
 (3) Crane Chain. Table for Eye Bolts.
 (4) Proportions of Hooks.
JULY.
 (1) Standard Boiler Rivets.
 (2) Length (Under Head) of Rivets.
 (3) Standard Round Slotted Nuts.
 (4) Inches to Decimals of a Foot.
AUGUST.
 (1) Size of Wire, Drills or Sheets.
 (2) Size of Wire, Drills or Sheets.
 (3) Size of Wire, Drills or Sheets.
 (4) Useful Factors.

MACHINERY.

September, 1903.

THE CURTIS STEAM TURBINE AND ITS MANUFACTURE.

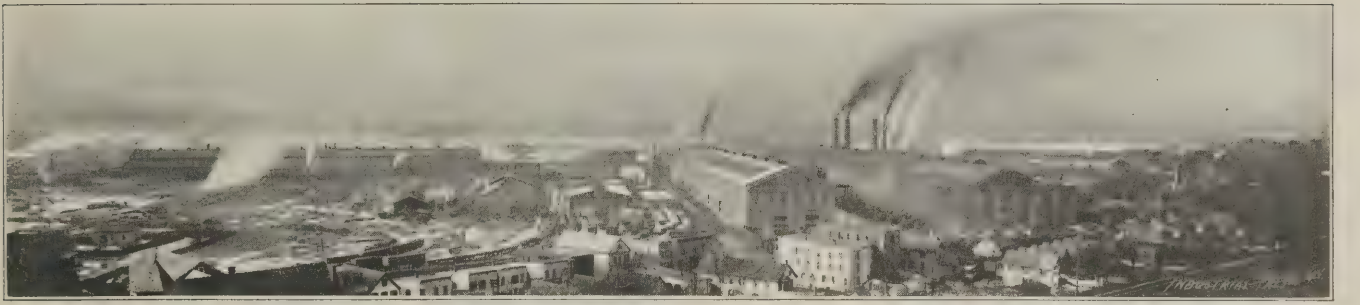


Fig. 1. General View of General Electric Works, Schenectady, from Mount Pleasant.

THE most important development in steam engine work since the time of George H. Corliss has been the advance in steam turbine building during the past ten years; and probably the most interesting step in this development has been the advent of the General Electric Co. in the steam turbine field. De Laval and Parsons had both experimented extensively in their native lands before their products were introduced into this country and when the Westinghouse Machine Company began to build Parsons turbines it was not looked upon as out of the ordinary, for that wheel was well known and the Westinghouse Company had manufactured steam engines for many years.

The General Electric Company, however, have confined themselves almost entirely to electrical machinery and the fact that they have prepared for the manufacture of a steam turbine, as yet but little tried and almost unknown, on a more extensive scale, if we are not mistaken, than any of their competitors, here or abroad, has aroused no little interest and speculation.

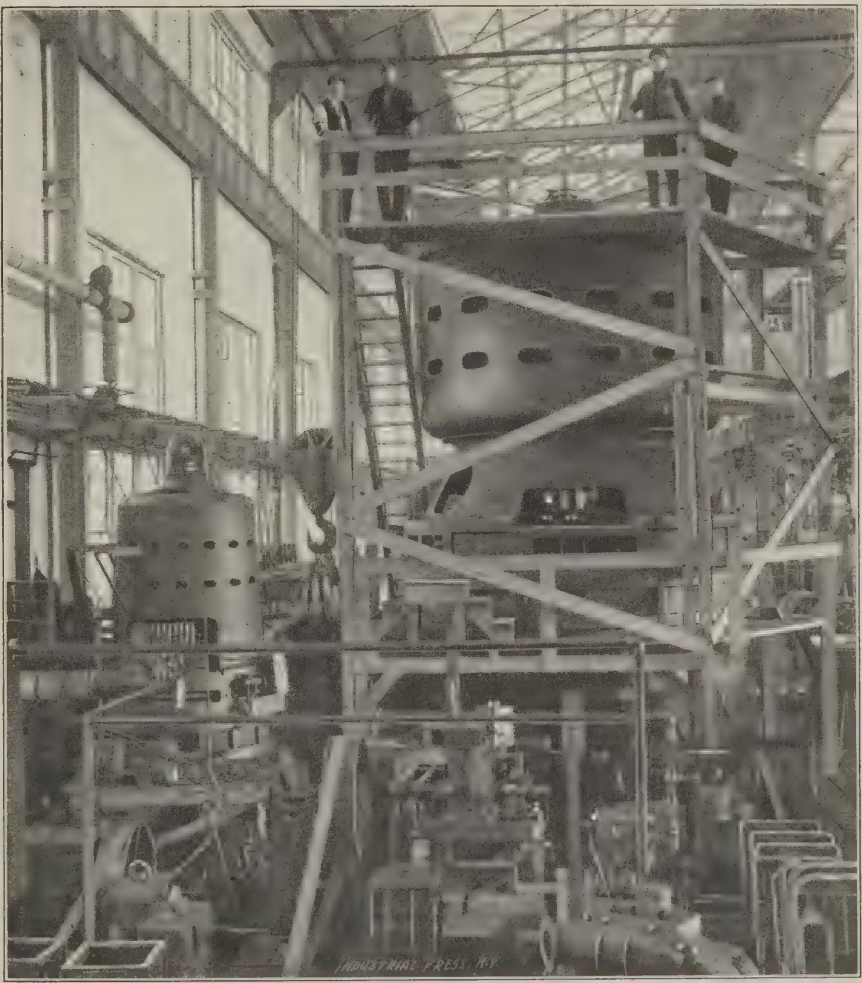


Fig. 2. Erecting the first 5000 K. W. Turbine and Generator. At the left is a 500 K. W. Turbine set under Test.

The first illustration on this page is a view of the General Electric Company's works, Schenectady, N. Y., taken from Mt. Pleasant, an elevation some distance to the rear of the plant. Most of the buildings are situated at the right of the center of the engraving. The largest one, near the center, is the main machine shop, which is one of the largest in the country, and the one at the center, a building 750 feet long by 150 feet wide, is a new structure devoted entirely to turbine manufacture. At the left, where the ground is seen to be broken, a new and larger building is now going up, which will be used for the manufacture of turbines, and as orders are ahead for 240,000 kilowatts of turbine units, it is anticipated that both structures may be needed to accommodate this remarkable business.

The second illustration shows the first 5,000-kilowatt turbine (6,700 horse power), direct-connected to its generator, in process of erection, and beside it a 500-kilowatt machine. The larger turbine was shipped to Chicago, and is one of several to be installed at the Commonwealth Electric station in that city. Compared with the vertical reciprocating engines of like capacity in the station of the Manhattan Railway Company, New York City, the turbine is, of course, very much smaller. It weighs about one-eighth as much, and one of this size can ordinarily be erected, ready to run, in four or five weeks, while the reciprocating engine is liable to require more than that number of months.

The turbine is designed to operate at 500 revolutions per minute and the vertical engine at 75 revolutions per minute. In point of economy the turbine will undoubtedly be greatly superior with fluctuating loads, since one important advantage of steam turbines is that the steam passing through them is not subject to alternate heating and cooling, as in the engine cylinder, and so it makes little difference in the slight loss from condensation whether much or little steam is passing through. It is expected that the variation in efficiency in this machine will not be more than three per cent. from half load to 50 per cent. overload. It is also expected that its regular economy will be better than that of its big competitor, for, granted that the passages through the turbine are correctly proportioned, expansion can be carried much further than in the steam engine. Steam at condenser pressure occupies a great deal of space and to provide for complete expansion in a steam engine the low-pressure cylinder must be impracticably large. There is also the great and irrecoverable loss due to condensation and re-evaporation in the steam engine which is entirely absent in the turbine.

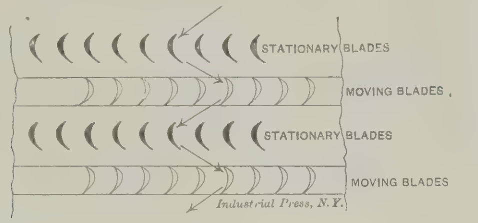


Fig. 3. Diagram of Parsons Turbine.

In Fig. 5 is a reproduction from a photograph of the 5,000 kilowatt machine. It is of vertical type with generator mounted above the turbine, the axis of each being vertical. One of the compound turbine wheels of this machine is shown in Fig. 6 and in Fig. 7 is shown one of the first Curtis turbines built, a 500 kilowatt horizontal machine, which has been running successfully for two years in the power house of the General Electric Company's works. The turbine wheels are arranged in two sets in casings, one on each side of the exhaust pipe appearing prominently in the illustration, and the generator is located at the right.

Before proceeding with further explanation of the Curtis turbine, it will be advisable to outline the general principles of the steam turbine in general, as a type of machine, and then explain the Curtis method of solving the problem. In any steam motor, provision must be made to expand the steam from boiler pressure down to atmospheric or condenser pressure, as the case may be, in order to utilize the full power of the steam. The method of doing this in the steam engine is too well known to need explanation; but in the turbine, where the steam flows in a continuous or nearly continuous current, it must be accomplished by making the passages through which the steam flows with sides diverging and cross-sectional areas gradually increasing. It is only by this means that the potential energy of the steam can be fully converted into kinetic energy, and the steam have its highest possible velocity, which velocity is to be transmitted to the buckets of the wheel and cause the turbine wheel to rotate. Theoretically these passages should increase in area directly as the specific volume of steam at the successive points and inversely as its velocity.

Steam issuing from a nozzle under these conditions will have a velocity of from 3,000 to 4,000 feet a second and if it impinges against the blades of a wheel the latter should have a peripheral velocity of about half this to utilize completely the total energy of the steam. In the De Laval turbine, which operates on this principle, the peripheral velocity is frequently as high as 1,200 feet a second, or as high as safety will permit with the strongest materials for its rotating member.

It is desirable, and in fact necessary, to secure a slower speed of rotation than this for best results, provided there is no sacrifice of economy in consequence, and this is brought about in several other types of turbines through compounding. A compound turbine may be built either for water or steam, and it is entirely possible for a water jet to flow at such great velocity as to make compounding desirable for a water turbine. The principle of compounding is very simple and is thus explained in Bodmer's textbook "Hydraulic Motors:"

"If a turbine is allowed to run at a much lower speed than at the best, the water leaves the buckets with a very considerable absolute velocity, and there is consequent loss from unutilized energy. This energy might, however, be usefully employed in driving a second turbine, the water, after leaving the first, being deflected by a set of stationary guide vanes to cause it to enter the second wheel at the proper angle. Both turbines could be keyed to the same shaft and their speed would be much lower than that of a single turbine driven by the same head of water and utilizing it to the same extent. This arrangement would constitute a compound turbine and it is clear that, instead of two wheels only, three or more might be employed in the same way, the speed being lower the greater the number of wheels. The only object in using a compound turbine in preference to a single one would be to reduce the speed in cases where the head was great and high velocity of rotation inconvenient or impracticable."

There are different methods of taking advantage of this principle of compounding, the first one to attract attention being that of the Parsons turbine, in which the steam flows through the wheel in a direction parallel to the axis and expands continuously from boiler pressure to vacuum. There are alternate rows of guides and vanes as in Fig. 3. The steam flows through a fixed ring of directing blades onto a revolving ring of similar blades, and so on, its pressure being reduced a few pounds, say two or three, at each step. Assume, for illustration, that the steam expands from 100 pounds pressure to zero in its passage and that there are 40 rows of guides and vanes. Assuming the coefficient of expansion to be the same throughout, the pressure would drop 2½ pounds at each step and the velocity of flow corresponding to this difference of pressures would be only about 400 feet per second, as against a velocity of some 3,000 feet per second, such as would occur if complete expansion were to take place in a nozzle at the start, before the steam came in contact with the blades. The theoretically correct peripheral velocity of the turbine wheel, therefore, would be one-half of 400, or 200 feet a second, as against 1,500 feet a second where complete initial expansion takes place.

The Curtis method of applying the compound principle is different from this and enables the wheel to be constructed with a fraction of the number of blades of the Parsons wheel, although it has the disadvantage of possible erosion of the passages, through the use of steam at much higher velocities. This action is much reduced, however, with superheated steam, and we are informed that it is not marked in the machine that has been under test at the works the past two years. In the Curtis turbine a steam nozzle is employed to expand the steam, and give it a high velocity before it comes in contact with the blades, but the expansion is not entirely complete in the nozzle, Mr. Curtis preferring to have a certain amount occur in passing through the wheel to overcome any retardation that may take place through friction between the blades and the steam. The nozzle is a modified form of the De Laval nozzle. The wheel is designed to run at a much lower speed than half the velocity of the impinging steam, so that when the steam issues from the first set of blades it has a high residual velocity; and this, in turn, is taken up in part by a second set of rotating blades, and so on.

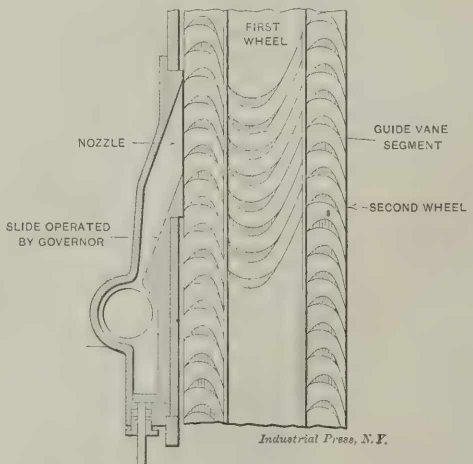


Fig. 4. Diagram of the Curtis Turbine in its Simplest Form.

For illustration, suppose the steam to start with a velocity of 3,000 feet per second; once compounding would reduce the required velocity of the wheel by two, or to 750 feet per second, instead of 1,500 feet, as with a single wheel; and

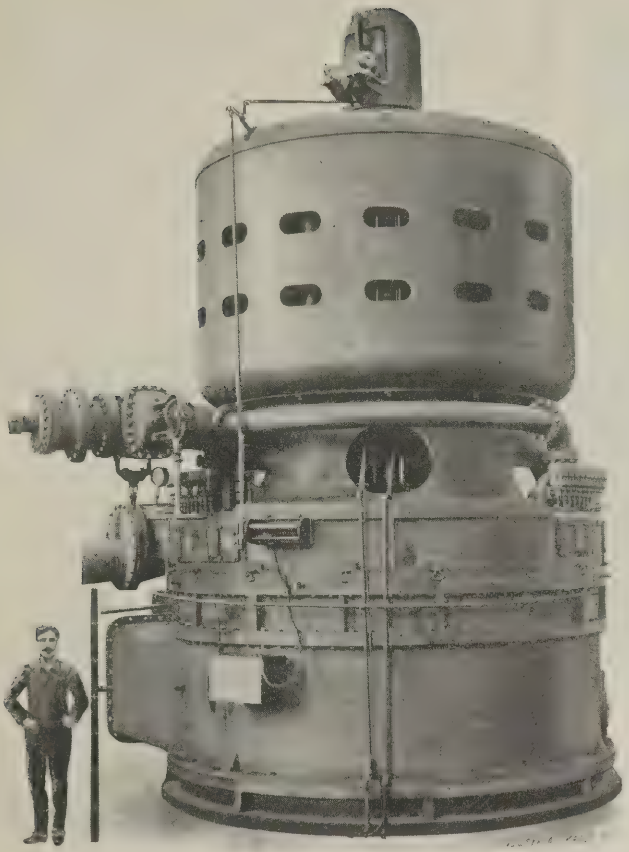


Fig. 5. 5,000 K. W. Curtis Turbine Direct-connected to Generator.

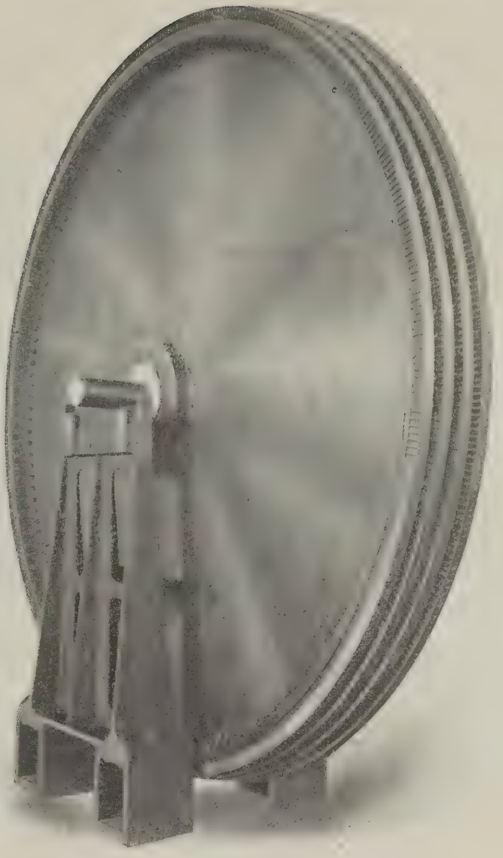


Fig. 6. 5,000 K. W. Turbine Wheel with Buckets Attached.

twice compounding would reduce the velocity to 500 feet per second. This simple illustration shows why the speed reduction under the Curtis system can be attained with so small a multiplicity of parts.

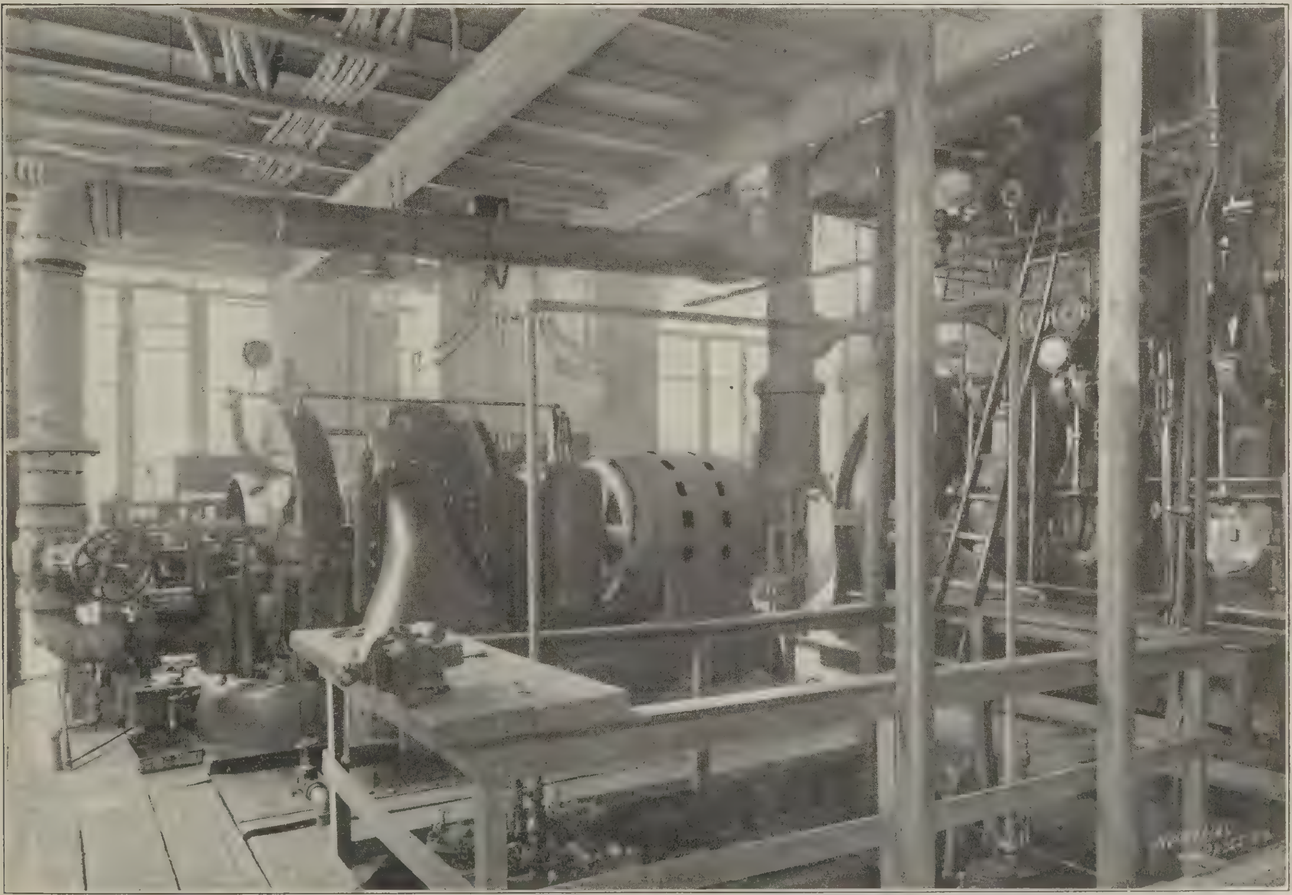


Fig. 7. 500 K. W. Horizontal Turbine, Direct-connected to Generator, operating in Power plant of General Electric Company's Works.

In its simplest form the Curtis turbine consists of two rings of curved buckets, as in Fig. 4, mounted upon disks revolving with the shaft. Between the two revolving rings is a group of curved blades in the form of a short segment fixed to the interior of the turbine case. The nozzle is of rectangular cross section, so designed that one side of it can slide under the action of the governor without altering the ratio between the inlet and outlet area of the nozzle, by which means the quantity of steam delivered is adjusted to suit the load.

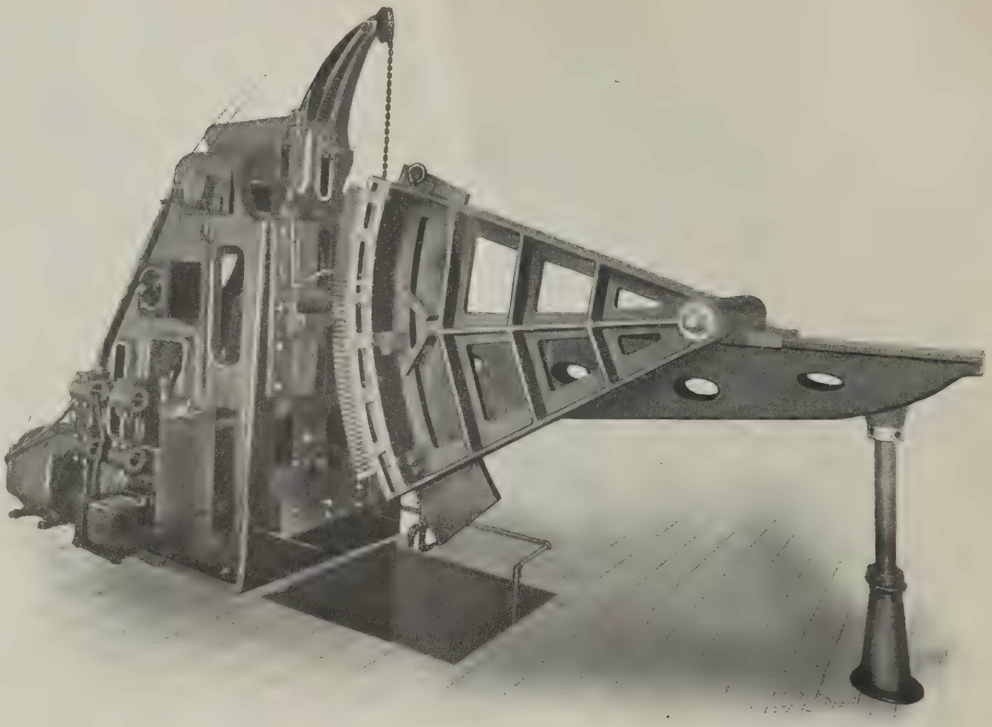


Fig. 8. Riddell Bucket Cutter at work on a Steel Segment, Cutting Buckets out of Solid Stock.

In its practical form, instead of there being a single nozzle, there are several ranged in a row, and instead of two sets of blades there is provision for several stages of expansion. The arrangement is shown in diagrammatic form in Fig. 12. Steam enters through the series of nozzles, forming a broad belt of steam, and the quantity admitted is regulated by a series of poppet valves, one for each nozzle. Regulation is effected by opening or closing these valves automatically, and for fine regulation, involving a less quantity of steam than flows through any one nozzle, throttling in one nozzle is resorted to. In the 5,000 kilowatt turbine there are three sets of these nozzles, spaced at 60-degree angles, and the steam passes through three sets of blades into an intermediate receiver, in which the pressure is approximately that of the atmosphere. From thence it passes through a second set of guide passages, or nozzles, which expand the steam nearly to the vacuum pressure and the velocity of steam is abstracted by three more sets of blades. The second row of nozzles occupies the whole circumference of the wheel, to allow for the great volume of the low-pressure steam. The turbine shaft is supported by a step bearing in which the thrust is taken by oil under pressure. The generator shaft is axially in line with the turbine shaft, and flexibly connected with it.

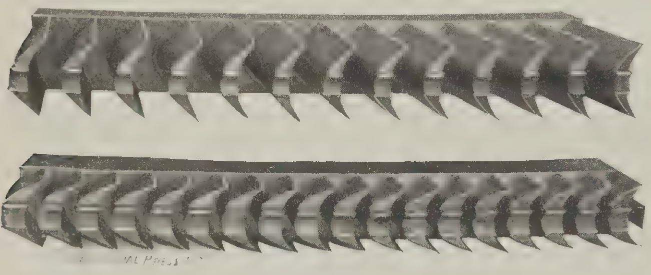


Fig. 9. Bucket Segments: The lower one for High-pressure Steam and the upper one for the Steam after it has expanded to a lower pressure.

Referring to the illustration of the turbine in Fig. 5, steam enters through the main steam pipe, which is shown connecting with two of the series of nozzles, and below is the casing surrounding the two turbine chambers and space for the intermediate receiver between. The governing mechanism is controlled by electrical connection with the governor, the latter being at the extreme top of the machine. In Fig. 13 is a diagram showing the principle of the device. The governor at G connects with a cylinder R on the surface of which is a series of contact points arranged spirally, so that, as the cylinder turns one way or the other, these points will come in contact successively with corresponding points from which the vertical wires extend and close the circuit through these wires in succession.

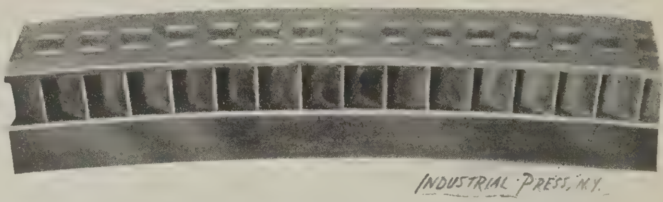


Fig. 10. Bucket Segment after Enclosing Ring has been Riveted on.

Referring to Fig. 13, A is the supply wire for the current, and B the return. The current passes through the switch S, which ordinarily is closed, and thence to the wire x and to the cylinder. The vertical wires at the left connect with the solenoids belonging to the various sets of nozzles, but in this diagram the horizontal wires leading to one set of nozzles only are indicated, which accounts for several of the vertical wires having no apparent connections. When the cylinder R is so rotated by the governor as to bring two contact points together, the current energizes the corresponding solenoid at T, and thence passes to the return wire B. Should the turbine speed up above normal, the governor arm drops and breaks the current at the switch S and all of the solenoids are thrown out of action and their valves close, shutting off steam.

The nozzle valves are not operated directly by the solenoids, but through the medium of small auxiliary valves which the solenoids control and which serve to create a balanced or unbalanced steam pressure, upon the faces of pistons attached to the nozzle valve spindles. One face of each of the pistons is

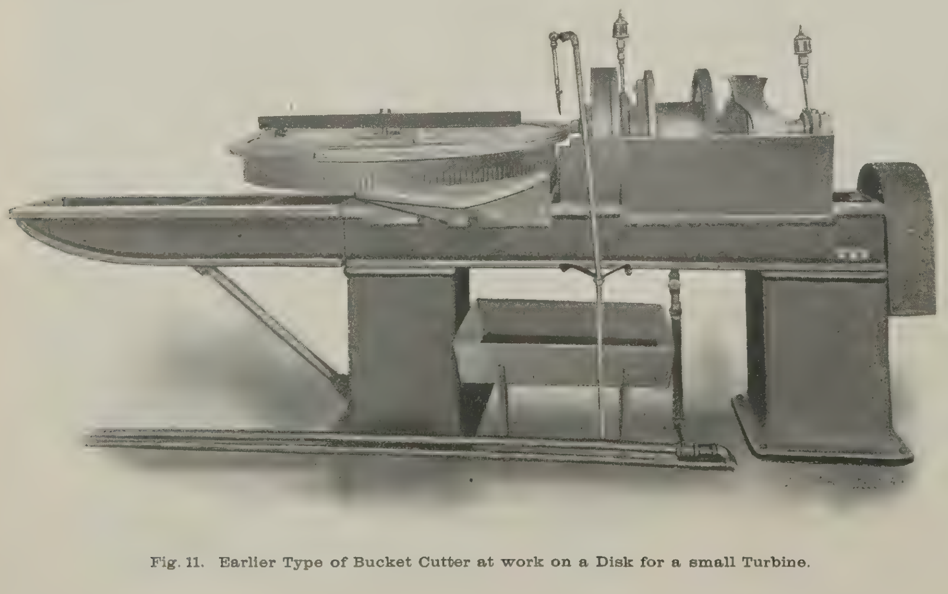
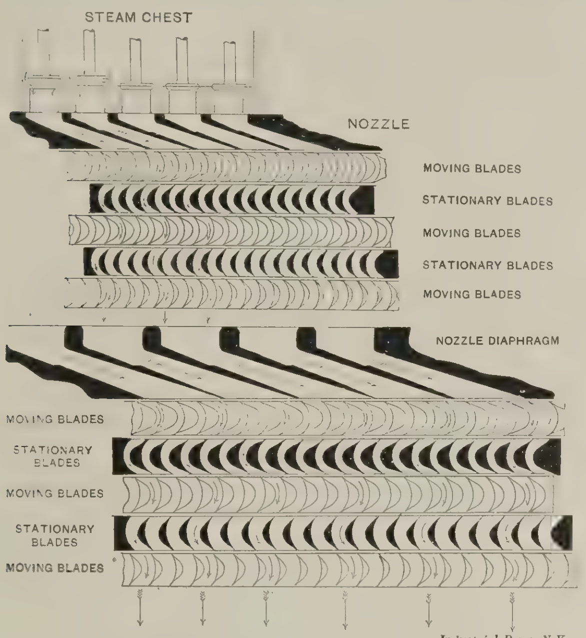


Fig. 11. Earlier Type of Bucket Cutter at work on a Disk for a small Turbine.

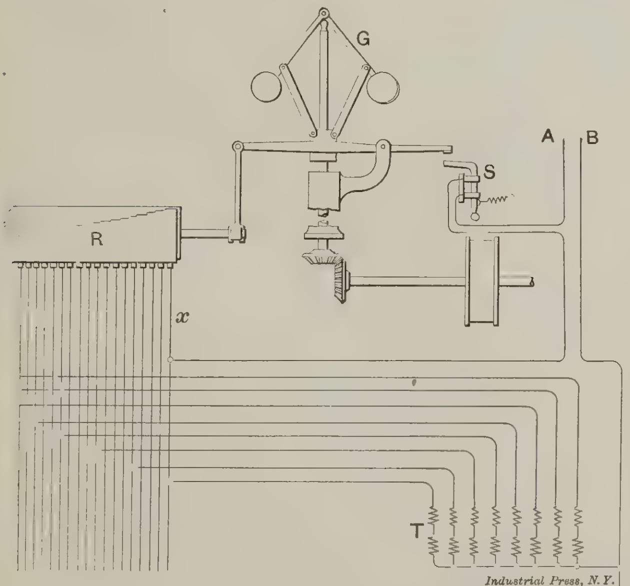
always exposed to the pressure within the steam chest and the auxiliary valve in one position admits steam to the opposite side of the piston. When this happens the pressure is balanced and the nozzle valve closes, the action being assisted by a small spring. When the cylinder space back of a piston or on the side away from the steam chest, is opened to the exhaust by its auxiliary valve, the piston is unbalanced and the valve will open, from the fact that the area of the piston is greater than that of the nozzle valve.



Industrial Press, N.Y.

Fig. 12. Diagram of Curtis Turbine in its Latest Form.

The most vital points in a steam turbine are the buckets, since they, and the spaces between them, must be shaped exactly right to give the correct direction of flow and highest mechanical efficiency, and also to provide for the progressive expansion of the steam. The buckets of the Curtis turbine are cut out of the solid metal by special bucket cutting machines. For the smaller sizes of wheels the blades are cut from the disks comprising the wheels, and for the larger sizes the buckets are cut from segments of steel and then bolted around the periphery of the disks. In Figs. 9 and 10 are shown bucket segments, in the first instance as they appear after machining and in the second with a rim of steel riveted on, closing the outer openings of the curved passages between the buckets. The view in Fig. 4, already referred to, shows the completed wheel of the 5,000 kilowatt turbine.



Industrial Press, N.Y.

Fig. 13. Diagram of Governing Apparatus.

While this process of making the buckets produces very nicely finished work, it is at best an expensive process, calling for special and expensive machines, which have taken a long time to design and develop. There are about twenty machines now in use. In all of them a single-pointed cutting tool is employed, the tool being so guided by the mechanism that its cutting edge will be in correct position for cutting effectively at all points of the curve. In the older machines the tool was given a motion of rotation around the circumference of a circle (approximately, depending on the shape of the buckets), and as it passed the bucket segment would remove a chip. The tool was gradually fed into the work as the cutting advanced. In the latest type the tool is given an oscillating motion, back and forth across the face of the segment. On the forward stroke the tool advances for the cut and on the return withdraws for clearance. The machine of this type is partly pneumatic in its action, and is an exceedingly interesting piece of mechanism. After the patents, now pending, are issued we hope to publish more about it.

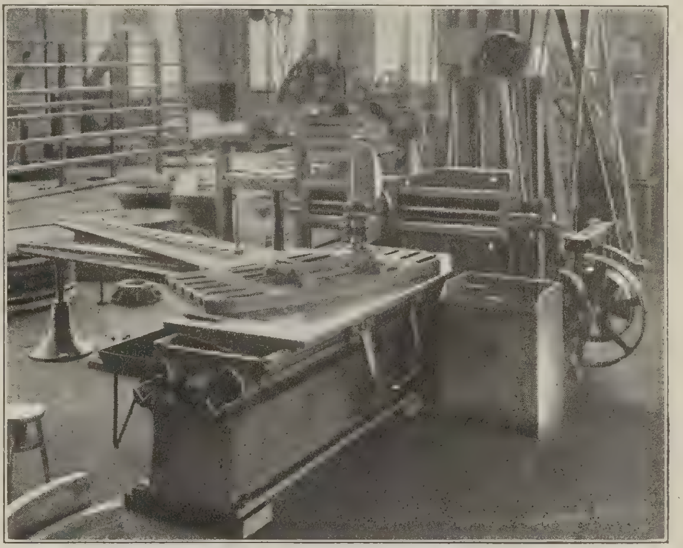


Fig. 14. Rig for Planing Bucket Segments.

* * *

I very vividly remember, while serving my apprenticeship as a machinist in a railroad shop that the temperature in the shop often dropped below 40 degrees and frequently to freezing if the outside weather was within 15 degrees of zero. With a temperature of 40 degrees a workman's hands become numb, and it is almost impossible to do good work with hand tools. This shop was considered by those in charge as being amply heated with an overhead direct steam system. The employees, instead of working to keep warm, as a rule chose to loaf to keep warm, and I do not believe that the amount of work produced on such cold days, when estimated very conservatively, amounted to more than 75 to 80 per cent. of the normal output. In this building there were about 150 employees earning approximately $2.50 per day; considering, however, the output to be 85 per cent. the loss on cold days amounted to something like $37.50.

An efficient heating plant for this shop would cost about $3,750 complete. Without considering the cost of steam, of which there was plenty of exhaust going to waste; allowing for depreciation, etc., making liberal total of 12 per cent. or $450 per year as the amount that the cost of the heating plant should earn, it would take only twelve days with the thermometer below 15 degrees above zero to make the expenditure a paying investment.—J. I. Lyle, in a paper before the New York Railroad Club.

* * *

What is called a triple typewriter is being manufactured by a concern in Cincinnati. The machines are built principally for use in large shoe manufacturing concerns in making out their order tickets for the factory. Nearly all such factories are divided into three departments, each of which requires separate tickets, and as these tickets are made of heavy cardboard carbon paper cannot be used to make duplicates. The triple typewriters are made from three single typewriters so joined together that they operate with one keyboard. The operator finds it no more difficult to operate one machine of this kind than a single machine.

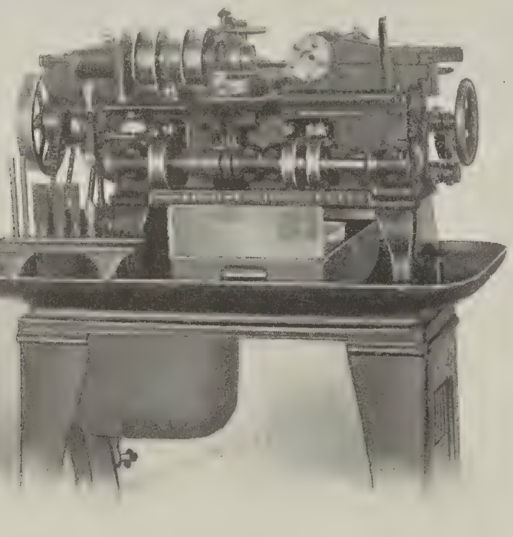
DIRECTIONS FOR CAMMING THE BROWN & SHARPE AUTOMATIC SCREW MACHINE.

RALPH E. FLANDERS.

The Brown & Sharpe automatic screw machine, as now made, has three tool carrying slides—a front cross slide, a back cross slide, and a turret slide. The back cross slide is controlled by a cam fast to shaft *A* (Fig. 1) through the medium of levers *B* and *C*, and the front slide is controlled by a similar cam through lever *D*. The turret slide is controlled by a cam on shaft *E* (Fig. 2) rotating in unison with the cross slide cams, and acting through lever *F*. The motion for feeding the stock, revolving the turret, and reversing the spindle, is taken from a driving shaft which runs at constant speed. Through change gears and a worm and worm wheel this shaft also rotates the cross slide and turret cams at a speed suitable for the piece being made. Bearing these essential points in mind, we will proceed to draw out the cams for making a model piece.

Laying Out Operations.

Fig. 3 shows a screw which was made of gun iron for a foreign rifle works. The particular dimensions on this piece are the diameter .1573, the length .630, and the thread .126 diameter x 42 threads per inch, or nearly No. 5-42. For these dimensions gages had been provided. The operations were laid out as shown; 1st, box-tool, to rough turn body size, and finish turn thread diameter; 2d, box-tool to finish turn body; 3d, die and pull out die holder for threading; 4th, form tool for finish around and under head; 5th, cut-off tool to sever finished piece, and neck and bevel unfinished piece for threading; 6th, feeding stock to stop in turret and revolving turret. The thread diameter is finished by a second blade in the first box tool, thus allowing the finishing box tool blade to clear this portion of the cut and shorten the throw required. The work is fed to a stop to bring dimension .630 correct.



Brown & Sharpe No. 00 Automatic Screw Machine.

Spindle Speeds.

In laying out a set of cams, the first point to determine is the rate of spindle speed. Gun screw iron can be readily turned and formed with a surface speed of 60 feet per minute. It has been formed at 90 feet per minute with fine feed, while with coarse feed it sometimes has to drop to 45 or 50 feet. Sixty feet per minute is, however, a conservative rate of speed for this job.

For threading on this fine pitch and soft material the rate may run anywhere from 25 to 40 feet per minute. It is well to remember that we can scarcely get the threading speed too low in an automatic screw machine, so the slower it can be done without sacrificing the production on the other operations, the better.

Now, consulting the spindle speed chart furnished with the No. 00 size machine, into which we will put this job, we find that 1,080 revolutions per minute appears to be the most suitable speed. This will give about 67 feet per minute for turning and forming, and about 35 for threading. To obtain the surface speed, multiply the diameter of the work in inches or fractions thereof by 3.1416 to find the circumference; multiply this by the revolutions per minute, and divide by 12 to get the answer in feet. Better yet, look up diameter and revolutions in one of the numerous tables to be found in catalogues and reference books.

Feeds.

For feeds, with this surface speed, .006 would be about right for rough turning, with .008 for the finishing cut. For forming this width, we could not safely take much more than .0004, with .0013 for cutting off. These feeds are given in Fig. 3, and refer in all cases to the thickness of the chip, or the distance the tool advances for each revolution.

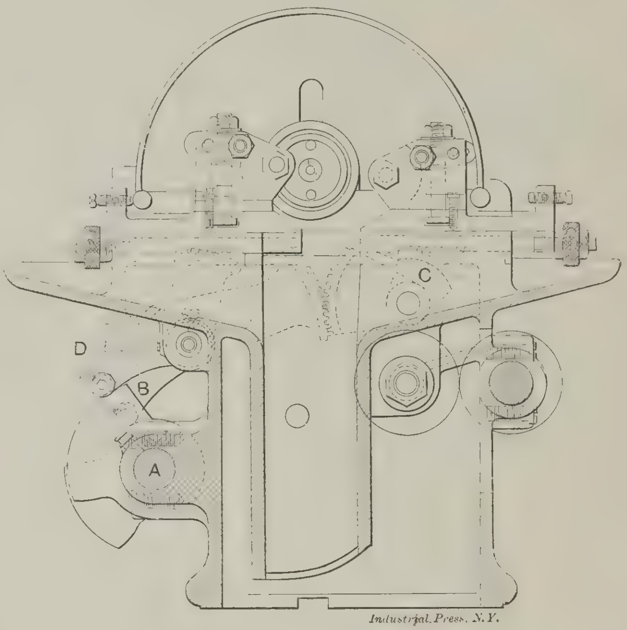


Fig. 1. Section showing Operation of Cross-slides.

Number of Revolutions to Make One Piece.

We next want to know about how many revolutions of the spindle it will take to make one piece. For rough turning we have a length of .630 to turn at .006 per revolution; this will give about 105 revolutions for this operation. (Note that the threaded diameter was rough turned by form tool, so that the first blade passes freely over this part without cutting.) It takes ½ second to revolve the turret on this machine. If the spindle goes 1,080 revolutions per minute; in ½ second it will go 1,080 ÷ 60 × ½ = 9 revolutions. Better add on a few revolutions here and make it 13 for good luck. Finish turning .630 in length with a feed of .008 will take .630 ÷ .008 = 79 revolutions. Revolving turret, as before, 13 revolutions.

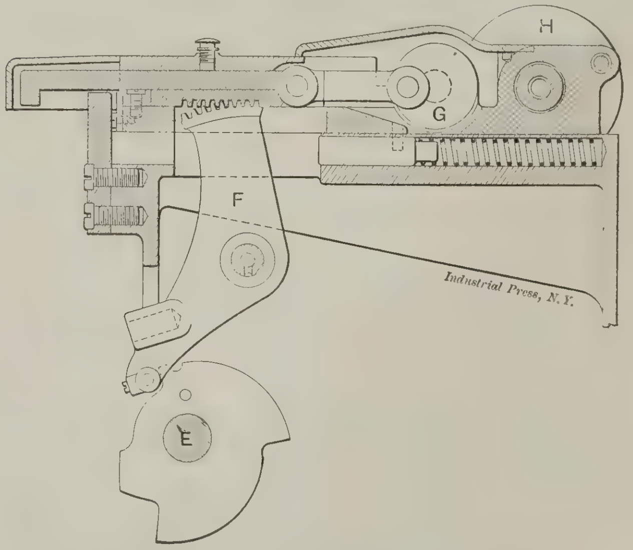
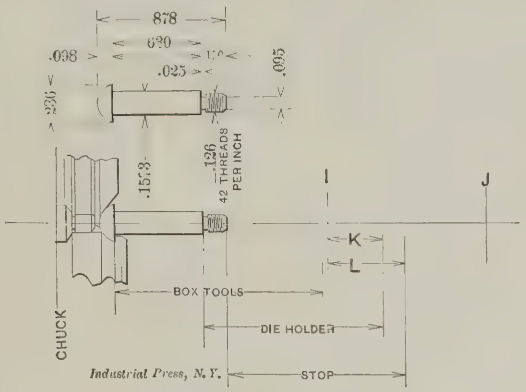


Fig. 2. Section showing Operation of Turret-slide.

To find the number of revolutions required for threading, we find the number of threads on the piece by multiplying the pitch, which is 42, by the threaded length .15; this gives us about 6. Add, say, 2 revolutions for clearance and multiplying by 2, gives 8 revolutions on and 8 revolutions off, or 16 revolutions for threading.

The next time the turret is revolved, the form tool is in action, so we need not reckon in the revolutions. We form from stock .236 in diameter down to .157, which gives a difference of .079 in diameter, or about .040 difference in radius. Add .003 for clearance, and call the throw of the form tool .043. With, say, .00043 feed, this will give 100 revolutions for this operation. To save time, we will overlap the movements of the front and back slides, timing the cams in such fashion that when the form tool has completed its cut, the parting tool will have cut into the neck between the screwhead and the chuck, as far as can be done safely and still support the work for the form tool to finish. In the present instance the back cut-off tool cuts down to a diameter of about .110 before the form tool was withdrawn. This gives us a throw of about .055. Now it will be noticed in Fig. 3 that the face of the cutting off tool is made on an angle. This is done, as shown in Fig. 4, to get rid of the teat which is always left on work parted by a dull, straight faced tool. This angular cutting edge causes the piece, in breaking off, to leave the major portion of the teat on the unfinished stock still in the machine, where the further advance of the tool shaves it off. Fifteen degrees has proved to be a suitable angle for steel and iron, while a somewhat greater angle, say from 20 to 25 degrees works better with brass or bronze. It is evident that we must add to the throw already found an amount equal to *S* in Fig. 4, which equals the width of the blade multiplied by the tangent of the angle. These values have been worked out in the table shown, for different widths of tool, and angles suitable for steel and brass respectively. With a blade .035 wide and an angle of 15 degrees, the by-travel amounts to .010. Besides this last allowance we should add on about .005 to provide clearance at each end of the movement of the tool. This gives us in all .055 + .010 + .005 = .070 for the throw of the cutting off tool to be used in estimating the number of revolutions of the spindle to make the piece. At .0013 feed this will give us .070 ÷ .0013 = 54 revolutions. Revolving turret as before, 13 revolutions. Feeding stock, same as revolving turret, about 13 revolutions. The total number of revolutions needed to make one piece, will be as follows:



Industrial Press, N. Y.

FRONT SLIDE.	TURRET SLIDE.	BACK SLIDE.
	Rough Turn—Box Tool .006.	
	Revolve Turret	
	Finish Turn—Box Tool .008.	
	Dwell.	
	Revolve Turret.	
	Thread—Die Holder and Die.	
Form—Circular Tool .0004.	Revolve Turret twice.	Cut-off Circular Tool .0013
	Feed Stock to Stop.	
	Revolve Turret.	

Fig. 3. Screw made on Turret Lathe and Operation of Slides.

Rough turn	105	revolutions.
Revolve Turret	13	revolutions.
Finish turn	79	revolutions.
Revolve turret	13	revolutions.
Thread	16	revolutions.
Form	100	revolutions.
Cut-off	54	revolutions.
Feed stock	13	revolutions.
Revolve turret	13	revolutions.
Total	406	revolutions.

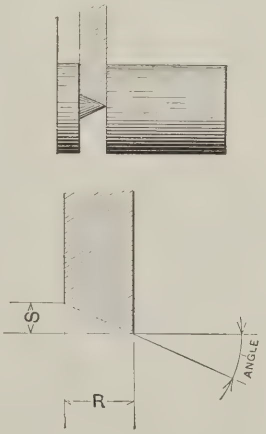
Our spindle speed is 1,080 revolutions per minute, or 1,080 ÷ 60 = 18 revolutions per second. Then it will take 406 ÷ 18 = 23 seconds, about, to make this piece. This will give a net production, after deducting 10 per cent. for sharpening tools, etc., of about 1,400 per day.

Laying Out the Cams.

Proceeding now to lay out the cams we will first lay out the lead cam by which the turret is operated. After we have drawn a circle to represent the diameter of the blank from which the cam is made, we will lay out on the circumference a distance sufficient for the first operation. It is best, in doing this work, to consider the circle as divided into hundredths instead of degrees and minutes and to facilitate this, it will be found convenient to use a piece of bristol board, cut out to fit the diameter of the cam blank, spaced off with the dividers, and graduated as shown in Fig. 5. This will save spacing off each circle separately.

The first operation, rough turning, took about 105 revolutions. If the spindle revolves 18 times per second; in the 23 seconds it takes to make one piece it will revolve 414 times, agreeing closely with our approximate estimate. If the spindle revolves 414 times in making one piece, or in other words, to one revolution of the cam shaft, each 1-100 of the cam periphery represents 414 ÷ 100 = 4.14 revolutions of the spindle. Then, if it takes 105 revolutions for the first operation, this portion of the cam will extend over 105 ÷ 4.14 = 26 spaces. Having found this division with our improvised protractor, draw a line through it and mark it 26, as shown on the lead cam in Fig. 6.

The next point to determine is the height of the cam lobe for this operation. Referring now to Fig. 3; lay off on the center line the nearest and furthest positions of the face of the turret in relation to the face of the spindle chuck, and draw vertical lines *I* and *J* through these two points. Now find on the box tool it is proposed to use, the working length, or the distance from the cutting edge of the first blade to the face of the turret when the tool is shoved in to the shoulder. After adding ⅛ to the dimension to allow for clearance and adjustment; lay off this distance from the point where the first box tool blade ceases action, toward the lines drawn to represent the position of the turret. As shown in Fig. 3, the dimension line marked "Box Tools" falls short of the advanced position of the turret, so we will bring this lobe up to its full height. Now lay off on the zero, or starting line, a distance *M-N* equal to the required throw for this tool = .630, and connect it by a spiral with the circumference at radial 26. This will be the first lobe of the cam.



R	15°	23°
.025	.007	.011
.030	.008	.013
.035	.010	.015
.040	.011	.017
.050	.013	.021
.060	.016	.026
.080	.021	.034
.100	.027	.043

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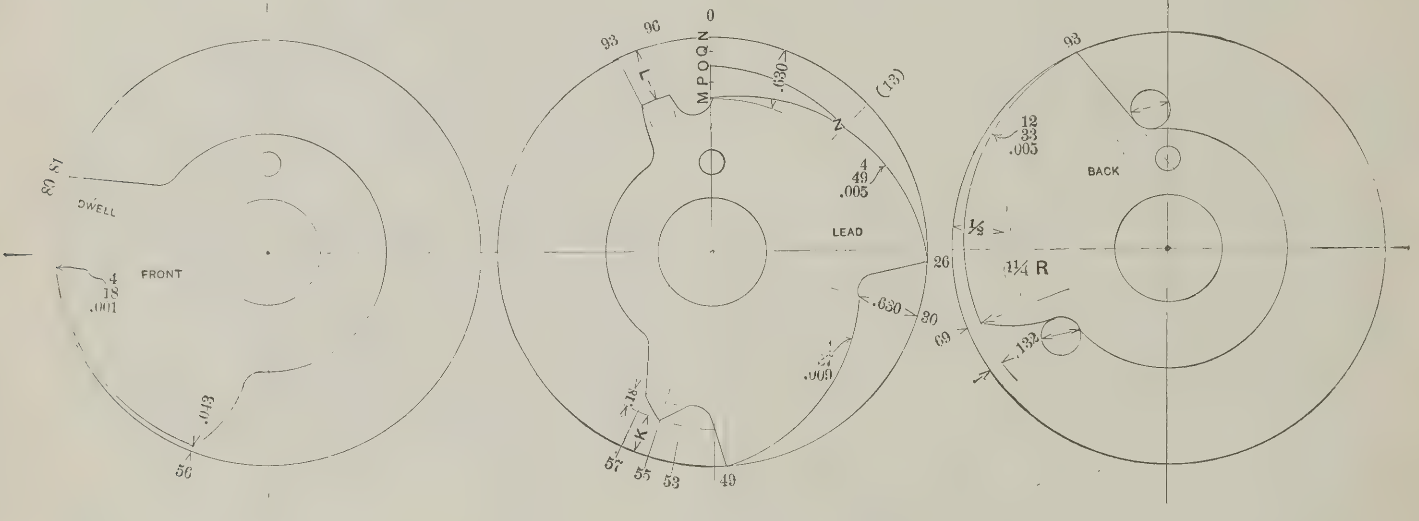
Fig. 4. Cutting-off Tool and Allowances for Angle of Face.

An approximate method of drawing this spiral is indicated. Owing to the length and steepness of this cam, we will have to draw it in two sections, so bisect the circumferential space of 26-100, at division No. 13; and there draw a radial line. Bisect the throw laid out (*M-N*) at *O*, and strike from this point an arc cutting radial No. 13 at *Z*. Again bisect *M-O* and *O-N* at *P* and *Q* respectively. With a radius equal to the distance between *P* and the center of the cam, connect points *M* and *Z*, and with a radius equal to the distance from *Q* to the center of the cam, connect point *Z* with the top of the lobe in the circumference at radial No. 26. This will be found a very close approximation to the theoretical spiral. Only one arc is usually needed to connect the starting and stopping points of the lobe, but sometimes it is necessary to draw a long spiral in as many as three or four sections.

It will be remembered that it takes ½ second to revolve the turret on this size machine. This makes 9 revolutions or 2-100 of the cam periphery. It will, however, ordinarily be found impracticable, when the diameter of the roll, and the angle of drop on the cam is taken into account, to get the roll down into position for a new cut in less than three spaces, and it is always well to add another space to give plenty of leeway, should it be found possible to speed the cams above the calculated rate of production. Our next radial will then be drawn four spaces beyond the last one, and will be numbered 30. Mark down on this line a distance equal to .630—the throw of the second box tool—as a starting point for the second cam lobe. We now wish to connect the top of the first lobe to the bottom of the second with a suitable drop. On the No. 00 machine, in anything from an 8-second to a 30-second cam, if the drop is drawn tangent to the 1¼-inch center hole it is about right. Cams faster than this will require an easier drop, while on slower cams it may be made a little steeper. Draw then a line tangent to the center hole from division No. 26 on the periphery and connect it with the starting point of the second lobe by an arc with a radius equal to that of the cam roll. The second lobe is drawn the same as the previous one—first find the number of spaces needed, here 19, draw a radial at division No. 49, and connect the two points with a spiral, substantially as before.



Front Cam. Lead Cam. Back Cam.

Fig. 6. Cams for making the Piece shown in Fig. 3.

The pitch of the threaded portion of the sample is 42 per inch. As this part is .150 long, there will be 150 × 42 or 6.3 threads on one piece; adding 2 threads for good measure, we have 8.3 revolutions, or 2 spaces as the portion of cam periphery needed for threading on. Furthermore, if there are 8.28 revolutions actual, in the 2 spaces, and the pitch is 42, the throw of the die will be $\frac{8.28}{42} = .197$. Die holders for use in automatic screw machines should be made to pull out against a light spring, in order that the turret motion may merely start the die on. The pitch of the thread will feed it into the work, while the turret lags after at a slightly lower rate. To allow for this, we will subtract about 10 per cent. from the amount given, leaving .180 for the throw of this part of the cam. Allow 4 spaces for revolving the turret as before; 2 spaces, as calculated above, for threading on; and 2 more for threading off; drawing radials at 53, 55, and 57.

Now find the height of this lobe of the cam. In Fig. 3, set the dividers to a distance equal to the amount the face of the die in the holder we intend to use projects beyond the face of the turret, plus ⅜ for clearance. Lay off this distance from point where the thread ceased; and dimension *K*, the length by which it projects beyond the line of the turret *I*, will be the amount we must cut down from the circumference of the cam. Lay off this distance on radial No. 55, and it will give us the top of the threading lobe. Measure down .180, our calculated throw, from this point on radials Nos. 53 and 57, and connect the points thus found with an arc—a single one will do here—substantially as before described.

It will be noted that it is unnecessary in this machine to make provision on the cam for carrying the turret slide to its extreme backward limit before revolving the turret. We merely let the cam roll drop down a little below the starting point of the next lobe; the crank disk and connected mechanism, indicated at *G* in Fig. 2, disconnects the slide from cam lever *F*, draws it to the extreme rear, revolves the turret, and again brings it up and connects it with the lever, ready for the next operation. This makes the time necessary for revolving the turret much shorter than if we had to let the roll clear down to the bottom of the cam each time. While the cross slide tools are in action, there is nothing for the turret to do, so drop the cam down 1⅛ below the circumference, the limit of the backward movement of the turret in this machine.

The next operation is forming, done by a circular tool in the front slide. As the thread on our sample is so far back on the piece, the dieholder and form tool are clear of each other, and the front cam may commence work immediately after the spindle reverses. In the circle which we have drawn for our front cam blank draw radial 56, 1 space beyond where the spindle reversed at 55 on the lead cam. One hundred revolutions were appropriated for this cut. This will give 24 divisions for the spiral, which should have a rise of .043 to agree with the calculated throw for this operation. In order to allow the tool to clean out the chip and give a good finish, in all cases where a tool is fed onto a finished surface, whether it is a box tool, a hollow mill, or a cross slide tool, it is advisable to add a dwell of a few revolutions at the end of the spiral on the cam. Accordingly, we allow another space from 80 to 81, which is made concentric with the cam shaft center, so that the tool may rest on the finished diameter for 4 or 5 revolutions. The cross slide cams are, of course, brought up to the full diameter as a rule.

Our allowance for cutting off was 54 revolutions, but it will be remembered that this accounted only for that portion of the cutting off which was done after the forming was completed. As there is plenty of time for it, as a measure of precaution, and for convenience in setting up as well, the throw of this cam should be great enough to sever the piece from the stock diameter, instead of waiting to commence work on the reduced neck left by the form tool. Of course the blade will be cutting air the first part of its travel, but experience shows that this will not dull the cutting edge. The diameter of the stock is .236; allowance for bevel on cut-off blade .035 wide is .010; clearance is .004; this will give $\frac{.236}{2} + .010 + .004 = .132$ for cut-off throw. With a feed of .0013 this means 100 revolutions or 24 spaces. By referring to our list of operations it will be noted that after the cutting off is completed we have to provide for feeding stock and revolving turret. The turret is revolved in 4 spaces as before; although the feeding of the stock takes the same amount of time, in practice it is seldom found necessary to add an extra space to that absolutely needed, so the allowance for this will be 3 spaces. This makes 7 spaces in all, so our cutting off cam will end at 100 — 7 = 93, and begin at 93 — 24 = 69. Lay out the cam between radials 69 and 93, with a throw of .132, and draw a suitable rise and drop. These quick motion curves should be drawn about as dimensioned for cams on the No. 00 machine. The builders send with the outfit directions for laying out those curves for the different sizes of machines, but if these are not at hand, a little judicious experiment will suggest what is about right for the case in hand.

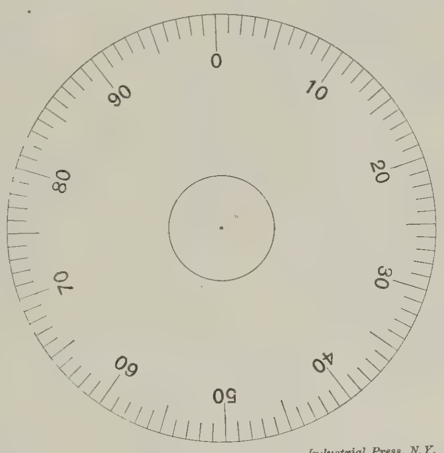


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Fig. 5. Protractor for Laying Out Cams.

Returning again to complete the lead cam, we lay out a lobe for the stock stop in the space between radials 93 and 96, which was reserved for feeding stock. This lobe is made a "dwell," and its height is determined from the stop we propose to use, in the same way as was described for the other tools in connection with Fig. 3. After making a little drop for the cam roll between 96 and 0, while revolving the turret, and having run up to connect again with the starting point, the cam is completed. To finish the sample up in good style, a pointing tool should have been used in the turret to clean up the thread end of the screw while the forming was in progress. As the party for whom the work was done did not care to bother with this, it was omitted, but the method for laying out a lobe for such an operation would not differ from that for the rest of the cam.

The first time the cams are outlined, make the pencil lines soft, as it is often necessary to make slight changes in the cams after they have been laid out and compared with each other. The calculations should also be gone over a second time, to see that no mistake has been made. Let us prove our calculations in regard to the depth the cutting off tool has penetrated at the completion of the forming. The total throw is .132, and the total number of spaces occupied is 24; of these 12 are simultaneous with the forming, so that the depth of cut reached at radial No. 81 is $\frac{12}{24} \times .132 = .066$. Subtracting the clearance, we have about .064. The radius of the stock is $\frac{236}{2} = .118$. The diameter of the supporting teat is then 2 (.118 — .064) = .108. As the form tool cut extends only about 5-32 beyond this teat, the conditions are well within the limits of good practice, that the length of surface formed shall not exceed 2½ times the supporting diameter.

If the thread cam had been a little longer and steeper, it would have been found advantageous to lay it out in a more elaborate manner. Fig. 7 shows the method. It is required to draw a threading lobe to give a movement of .625 in 4 spaces on, and 4 spaces off, the lobe to be cut down ¼ inch from the circumference. Supposing the apex of the cam to be on radial No. 75; with center on this line draw a circle equal in diameter to the cam roll, with its bottom the required distance (¼ inch) from the periphery. Through the center of this cam roll draw an arc concentric with the cam and cutting radials 71 and 79. On radial 79 lay off from this arc, toward the center of the cam a distance, .625, equal to the required throw. Now divide this distance, and the arc on either side of radial 75, into any convenient number of parts, 4 in this case. With compass point at the center of the cam and a radius *T* equal to the distance between the center of the lead cam and the fulcrum of the lead lever, strike an arc. With centers in this arc, and a radius *U* equal to the distance from the fulcrum of the lead lever to the center of the roll, strike arcs through the center of the cam roll circle, and also each of the division points in its arc. Draw arcs also concentric with the cam through the division points on radial 79. Where each of these arcs intersects its mating arc drawn from the fulcrum of the lever, draw circles the diameter of the cam roll, as shown in the figure. If we now draw curves on each side of radial 75 tangent to the under side of these cam roll curves, we have our lobe. It will be noted that this lobe is narrower than the space between 71 and 79, that it is less than .625 high, and its apex is more than ¼ inch from the periphery, but if carefully laid out and made, it will give the required results with a pull out die holder.

General Remarks.

A few points to be careful about are copied here from a note book in which the writer has recorded some of his mistakes. Give plenty of clearance between operations when there is any likelihood of interference between cross slide and turret tools. Be sure that all possible burrs are removed. Always either feed to stop or face end to length where accurate work is required. Always be sure, especially in pieces made in 6 or 8 seconds with few turret tools, that time is given to revolve the turret clear around past the unused holes while the cross slide tools are in action. The different tools and operations should be arranged in such fashion as to completely remove the burrs thrown up by the different cuts. This can be done in nearly every case. We are not limited to the production for which the cams have been calculated. For instance, in the case we have been considering, we might find the stock so soft that a spindle speed of 1,320 revolutions per minute could be used. It took 414 revolutions to make one piece, so with the new spindle speed, 418 revolutions, taking 19 seconds to revolve the cam shaft, will give practically the same feeds throughout. Again, if the feeds are a little easy or a little too stiff, we may simply change the number of seconds the cam shaft is timed for, by altering the gears, as we have made provision for a little extra space for revolving the turret. When the production is changed in this way, it is sometimes necessary to change the thread lobe a trifle, but none of the other lobes need be touched.

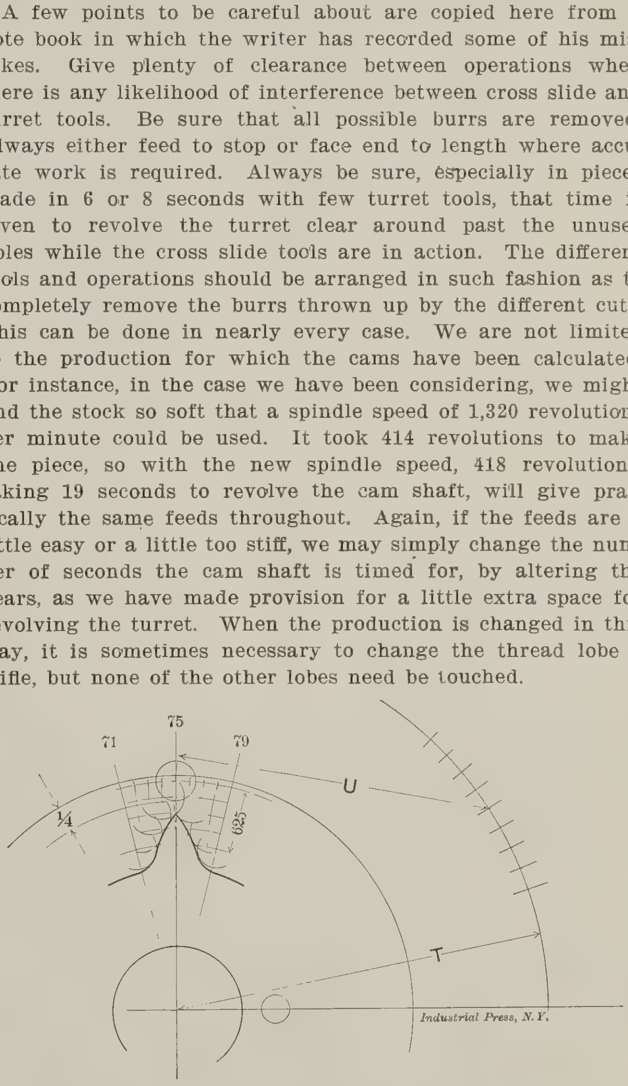

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Fig. 7. Method of Laying Out Threading Lobe.

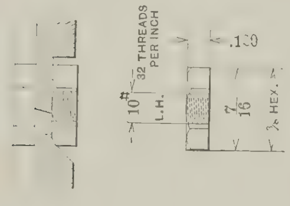
The cams are preferably made of mild sheet steel, of suitable thickness, finished on the periphery and casehardened. Plain forming and cut-off cams, and sometimes lead cams for the larger machines, when of strong design, are made of cast iron finished all over. The blanks should be turned to size and have the center hole bored and the driving hole drilled from a template. Make a copy of the cam drawings, with a hard, round ended pencil and a sheet of carbon paper, on a piece of tough manila. Include the center hole and the dowel hole in this copy, as it is by means of the small hole that the cams are timed together. Cut out the template thus drawn, locate it in position on the cam blanks, and carefully scribe the contour onto the metal. With drill and cold chisel remove the surplus stock and finish up the rises, drops, and idle periods with the emery wheel and file, leaving 1-16 inch or so for finish on the working surfaces. For the steep pitches, such as the thread lobes and possibly the two box tool lobes, the curve may be worked out with the file until it matches the drawing, but to get an even rise on such a slight pitch as that of our cross slide cams, it will be necessary to mill the spiral. To do this, place the cam on an arbor held in the index centers of a milling machine, drop a cutter onto the highest point of the cam, and alternately raise the knee and rotate the index head by suitable amounts until the entire surface is finished. "Millings," as they are termed, are given for the different lobes of the three cams, and they are read as follows: $\overset{4}{\underset{.001}{18}}$ on the front cam means that the index finger is to be moved 4 holes in the 18 circle, and the knee raised .001 for each cut; $\overset{12}{\underset{.005}{33}}$ on the back cam shows that we must index 12 holes in the 33 circle, and raise the knee .005; and so on.

To find the milling for the first box tool lobe on the lead cam, for instance, first find the lead, or the throw it would have if continued for a complete revolution; this will be equal to its present throw, divided by the per cent. of the circumference it occupies. $\frac{.630}{.26} = 2.423 =$ the lead of this lobe. Now divide this amount by any convenient quantity we may settle upon as the distance we will raise the knee for each cut. This quantity may be larger for a steep pitch, and smaller for a slight pitch. Suppose we settle upon .005; $\frac{2.423}{.005} = 485$. Four hundred and ninety is the nearest number of divisions we can get on or index head by plain indexing, and the table calls for 4 holes in the 49 circle. The amount the knee is raised being .005, the "milling" will be $\overset{4}{\underset{.005}{49}}$ read as explained above. To prove the millings, proceed as follows: $40 =$ number of teeth in index wheel; $.26 =$ per cent. of periphery occupied by lobe; $\overset{4}{\underset{.005}{49}} =$ the milling. $\frac{49}{4} \times .005 \times 40 \times .26 = .637$. This exceeds the calculated throw, but is near enough. If the two steep box tool lobes are milled, it would be advisable to use a convex cutter with a radius of cut about equal to the radius of the cam roll; this will lessen the stepped appearance the corner of a straight cutter would give to the rise. After the lobes are milled, the surfaces should be filed smooth and polished, and the cams tried in the machine before hardening. The lead cam should be stamped with the name of the piece it is to make, the spindle speed, the change gears used, and the name of the cam.

Examples of Layouts.

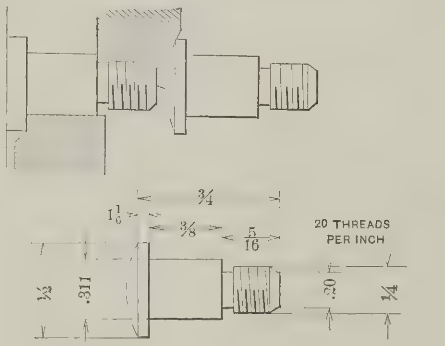
A few samples are here illustrated, showing the operations, feeds, speeds, and production. It is to be understood that, on rougher work, both the feeds and speeds might be greatly increased. Another factor which might tend to greater production is the use of some of the high speed steels for roughing tools. Turning our attention to the samples illustrated, it may be interesting to notice the important points in each one. The first column relates to the front cross slide, the second to the turret, and the third to the back cross slide, and the feeds are given for each operation. When two or more items are included in parentheses, it indicates that they are all done by the same tool.

The small brass nut, sample 1, is made from hexagon stock. Brass may be turned at the highest available speed of the machine, but it is seldom expedient to thread at over 1,500 to 1,800 revolutions per minute. In deep drilling in brass, one is more liable to get the feed too fine than too coarse. A fine, broken chip will quickly clog up the flutes of a twist drill, while a heavy stiff chip will push straight out. It will be found advantageous to use straight fluted drills on this metal. The centering and facing is done with one tool, and the feed is reduced when the facing blade commences its work. The cutting off tool is given a regular feed until the point has severed the completed piece, and then the feed is doubled while the tool cuts through the air in the hole. It is always advisable to cut to the center to avoid the trouble that would follow if the drill broke and the work was not severed from the stock.



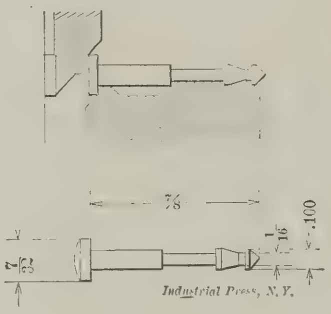
Sample 1.

Material—Brass.
Spindle, 1,440 R. P. M. Seconds each, 10.
Net production, 3,200 per day (10 hours).
(Center .0042, Face .0021, Dwell.)
Revolve Turret.
Drill .0058.
Revolve Turret.
Tap.
(Form .0012, Dwell.)
(1st cut-off .002, 2d cut-off .0042)
Feed Stock.



Sample 2.

Material—Steel
Spindle {Forward 300 R. P. M., Backward 600 R. P. M.} Seconds each 70
Net production 450 per day (10 hours).
(Form .00029, Dwell.)
(1st cut-off .0014, 2d cut-off .00064, Dwell.)
Thread.
Revolve Turret.
Feed to Stop



Sample 3.

Material—Steel.
Spindle, 1,320 R. P. M. Seconds each, 30.
Net production, 1,000 per day (10 hours.)
Rough Turn—Hollow Mill .0073
Revolve Turret.
(Finish Turn—Box Tool .009, Point. .001, Dwell.)
Revolve Turret.
(1st Form .0011, 2d Form .00016, Dwell.) Support.
Cut-off .0013
Feed Stock

Sample 2 is an example of the method of making commonly known as "cut-off and form." Wherever the turned portion is less than about 2½ times the supporting diameter, this method will usually give the greatest production. Much longer formed cuts can of course be taken if the work is supported by a back rest in the turret. In this piece, as well as in the others shown, note the means taken to remove all the burrs possible, and so leave the work nicely finished. The form tool cuts off the burr thrown up by the cutting-off tool in necking for the thread, and by means of the 45 degree angle, cleans up the under corner of the head. The cross slide tools are set to cut with the spindle running backwards at double speed, thus greatly increasing the production, while the threading speed is kept within limits.

Sample 3, a part of one of the standard typewriters, is an extreme example of long forming. It will be noted that two feeds are used for forming. The tool takes a chip of .0011 when finishing under the head, but is slowed down to .00016 when the wide cut starts in. The work is supported by a turret back-rest bearing on the two thin strips of body diameter at the end of the piece. These examples show some of the simpler forms of work done on these machines. This system of cams lends itself very readily to complicated combinations, and the cams, tools, and attachments for some of these operations are very elaborate.

MACHINE SHOP EQUIPMENT.*—1.

PLANNING THE DIFFERENT DEPARTMENTS.

OSCAR E. PERRIGO.

We will assume that our machine shop has been erected according to the methods suggested in the former articles on the subject, which discussed the plans and mode of construction of foundations, walls, roofs, and floors, and properly provided for the prime necessities of light, heat and power. Our next duty will be to describe and illustrate its equipment with the proper machinery, tools and appliances for accomplishing the contemplated work to be done. Machines should be so arranged in groups or departments as to best subserve the purpose intended, and to manufacture the product with the least cost for handling the materials in the various stages of their progress toward the completed product, and with the most efficient arrangement for supervising the work, and still to insure the desired standard of accuracy, finish and thoroughness of the completed output.

In considering the question of the proper equipment of a machine shop a great deal depends upon the character of the product which is to be turned out. It may be that of heavy machinery requiring little or no machining except of surfaces in contact, as is the case with such work as sugar mill machinery, rolling mill work and similar product which will necessitate heavy castings and consequently a large proportion of machines for heavy planing, boring, drilling, tapping and so on, as well as large erecting space and much use of the traveling crane and other forms of lifting devices. Again, it may be of a generally lighter kind of work, as for instance, steam engines of various sizes and similar work where much more finish as well as very accurate fitting is required. Or, it may be of machine tools, the larger of which will be similar to the engine work in many respects, while the smaller machines will require a large variety of machines both for general and special work and such as are capable of producing a large quantity of very accurate work even on rather large parts.

The design of these articles is not to arrange and specify such an equipment as may be required for any certain kind or class of manufacture, or for any special line of sizes of machines, for that is manifestly impractical, but rather to suggest the proper selection and arrangement of the machines for a medium kind of work, on a practical plan which may be useful to those having charge of this class of mechanical engineering and be helpful in pointing out such machines as will be most economical in the production of certain classes of work in the more modern and up-to-date methods, and so grouping and arranging them as to make their management easy, practical and profitable.

In this connection it will not only be proper to offer some suggestions as to the class or type of machines best adapted for certain kinds of work, but also as to the methods of testing such machines to ascertain their fitness for the work to be done on them. These requirements become all the more imperative since the demand is more and more pronounced for machines of higher speed, greater strength and consequently capable of a largely increased output, as well as for machines whose parts may be rapidly changed to adapt them to a large variety of work. To this is added the demand for greater accuracy, better fitting, a superior quality of stock in their make-up, more carefully considered design and a generally finer finish.

In all the operations of manufacturing, from the very conception of the idea that we *will* manufacture, to the final marketing of the product, if we are to expect success, either in the building, the equipping, or the management of the manufacturing operations of such a varied and complex nature, we must first of all have a well-conceived, well-matured, definite and comprehensive *plan*. If this is not so we shall find the various component parts of our fabric disproportioned to each other. One will be of too great capacity and another of too little; one portion will be an unnecessary expense which will absorb the profits of another; one will be pushed while another is neglected; and so on until the whole establishment is in such a disjointed, disproportioned and inefficient condition that success either mechanically or financially is impossible. This is very forcibly shown in cases where a business that "ought to pay" seems to drift along from year to year with scarcely any advance in methods or profits to its owners. Another man takes charge and perhaps astonishes everyone by his seeming extravagance, but gradually order comes out of chaos, the expenses which at first staggered the good old conservative directors begins to tell and in due time everything is in proper condition, every portion of the concern does its allotted part, each in harmony with the others, everybody is cheerful and satisfied, better work is produced and the stockholders are getting their dividends. Why? Simply that the man is master of the business and works with a well-conceived plan. He knew from the beginning just what would be the result; he was not afraid to make radical changes; there was no patchwork about it. Every portion of his plan was carried out in its entirety. Two different parts do not make a complete whole, and to have several plans in mind and then attempt to carry out a portion of each is but to invite failure. And the invitation is usually accepted. This is also true even in regard to minor operations in the same line. We must get such a grasp of the complete idea and plan in all its details that "from the beginning we can see the end." One of our most successful designers of machinery always seemed to be a good deal of a laggard during the first stages of a new design and would draw and sketch and measure in what seemed a very desultory sort of a way. When remonstrated with for what "the boss" thought was wasting time, he used to say, "I don't wan't to make my drawing until I can shut my eyes and see the machine working." The complete conception of the design as it gradually forms in the mind is what is needed. And when a man had the ability to thus "see through" the whole design, the "working up" of the various component parts is to a great extent matters of mechanical detail only.

So it is, or should be, in planning manufacturing operations. We must see the end from the beginning. This applies with peculiar force in the alterations of or additions to plants already in existence, whether it be the changing on account of a different product to be manufactured, or of enlarging so as to increase the product. The plan should be comprehensive and provide for possible enlargements in the future, so that as each successive change is made we get nearer and nearer to the ideal of a completed structure that will be a credit and not a continual "eye-sore." Not only in appearance is this the proper method, but in the utility of the improvements made, and this again in proportion to the expense incurred. If any "piece-meal" plan is adopted from time to time the result will be not only a failure to get the greatest accommodation out of the improvement, but to do so at an expense which is frequently lost by subsequent alterations of such a nature as to compel us to tear down a portion of the former work. And this process is repeated again and again until the expense of successive changes, additions and alterations will have cost more than to have built the whole structure new. Beside this we have a mongrel structure in which "the last state is worse than the first." It is frequently better to make new things than to patch up old ones; ofttimes it is cheaper also. And this lesson may be followed through all the operations of manufacturing with good results to the reputation of the man who is responsible for the plans as well as the success of the establishment and the dividends to the stockholders.

It was from considerations such as these that in the first article (printed in the October number, 1902,) on Construction, it was pointed out how the capacity of our manufacturing plant might be economically increased and at the same time work along the same general lines so that the enlarged structure would be but an extension or expansion of the original plan.

In planning the relative location of the different departments of our machine shop in which are placed the several classes of machines it is necessary to so arrange them that when once the material, as iron castings or other heavy

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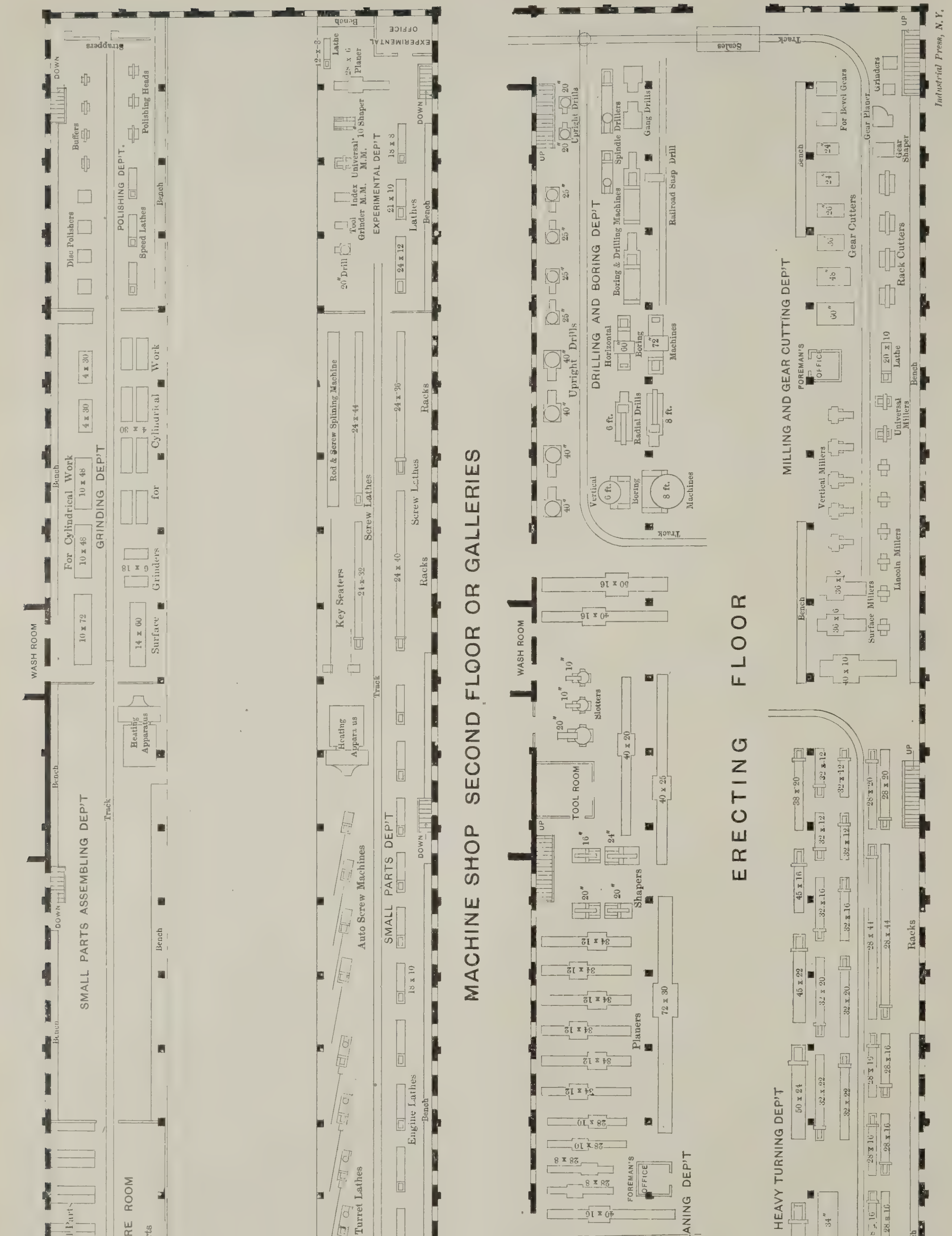
* Supplementing the series upon Machine Shop Design, begun in the October, 1902, number, and ended in May, 1903.



Arrangement of Tools and Departments in Model Machine Shop, previously Described by the Author.

stock, comes into the shop, it shall pass in as nearly as may be a continuous line through the shop from its rough state to its place in the erection of the machines to be built with little or no "retrograde movement" or other unnecessary handling or similar expense. Light and easily handled stock is not subject to these conditions to such an extent, and may be handled on the upper floors as its transportation from place to place is easily effected by the tram cars, trucks, etc., on the level, and these run upon elevators, and carried to the various floors where they are needed for the different operations upon them, or to a finished parts storeroom, where they may be kept until they are wanted for the assembling of a complete machine. In our case, however, having but two floors, quantities of small work may be packed in trucks, cars or boxes and from the front gallery lowered to the ground floor by the traveling crane. In the same way stock or finished parts may be brought up to the gallery floors.

The plans accompanying this article show both the ground floor and the gallery floors, with the location of all the machines selected to equip the shop, arranged as is thought best for the easy handling of the stock and the convenient performance of all the necessary work of machining, erecting and shipping. The machines are all shown drawn to scale, and with sufficient space around them for readily handling the stock and the machined parts.

The main floor is divided into five departments, namely, the planing, drilling and boring, heavy turning, milling and gear cutting, and the erecting departments, all located as shown on the plan.

Usually the first operations on nearly all castings and on many forgings is that of planing, this being particularly so with the heavier stock. Consequently it is advisable to locate the planing department near where this class of stock can be the most readily received into the shop from the foundry or from the forge shop. As by far the larger amount comes from the foundry the point nearest that department is where the planers should be located, so as to save distance in conveying material, and consequent expense. Our tram track leading from the foundry to the machine shop brings castings to a point nearly under the traveling crane (by which they are readily placed upon the planers on each side of it), or directly under it, by which it conveniently serves the large planers located in the erecting space just inside the row of columns. An overhead trolley delivers castings to the other planers in the row arranged at right angles to the shop as they are taken from the foundry cars, or carries them, when planed, to the tram track and thence by the traveling crane to any part of the shop where they may be needed, generally to the tram track laid through the drilling and boring department, or to the large machines of this class located within the reach of the traveling crane inside of the columns. This overhead trolley may be operated by hand hoists, or by compressed air, but preferably it should be of the type carrying a small electric motor by which it is very quickly, efficiently and conveniently operated. There should be at least two of these hoists on the trolley track, which should extend from the front end of the shop down to and over the tram track in the drilling and boring department.

It should be explained that in laying out the positions of the planers the outline shown includes the extreme run of the planer table, hence there is more space at the ends than would appear at first glance. In locating the planers with reference to each other they are placed at equal distances of five feet between tables without regard to the front or back, so as to give free access to both sides when the operator is putting on, setting or removing work. Those of the larger planers are located parallel with the length of the shop. It will be best to drive these with electric motors. The other planers, of such sizes as will accommodate the usual variety of work, are located according to the space available. Much of the medium sized work may be done on long planers very economically by filling the table with as many parts as it will hold, and running through the lot with a long cut, as for instance, with lathe heads or carriages, which may be planed in lots of ten to fifteen much cheaper than a less number on a short planer. The two planers near the wash room are convenient for comparatively large work where a short table is required. The other planers are arranged in pairs facing each other so as to be convenient for one man to run two planers. One man can easily run the 60-inch and the 72-inch planers.

In connection with the planers are located the shapers and the slotters, as shown in the plan. These are also served by the overhead trolley as noted above, and work from them, or from the planers may be thus conveniently moved to the drilling and boring department unless the parts are so large as to make the traveling crane necessary.

Next in the order of work is usually that of boring, either in vertical boring mills, horizontal boring machines, radial drills, etc. Therefore this class of machines will naturally come next to the planers, and on the same side of the shop, in the drilling and boring department. The vertical boring machines are of the usual type in which much of the large work, such as pulleys, balance wheels and many other heavy parts are much more readily handled than upon a lathe. The horizontal boring machines are those with the low, traversing table, and elevating head and tail stocks, while the horizontal boring and drilling machines are those with a stationary head and an outer support for the boring bar, and a vertically adjustable table supported by two vertical screws. The first is adapted to heavy work, while the latter handles that of medium weight. The so-called railroad suspension drill is one provided with a perfectly level track upon which long beds, as lathe beds, may be supported on rollers and run to any desired point in their length for drilling and tapping. Assuming that there will be hollow spindles required, two spindle boring machines are provided. These may be of the horizontal cylinder type for the purpose of feeding, where only one tool is used, or with a heavy turret and slide when more than one tool is required. Two gang drills are provided for jig work where medium or small sized holes are needed. Next to the wall is a row of ordinary upright drills of the capacity indicated. Where necessary, small jib cranes should be attached to the columns for use at individual machines, or for a pair of machines.

The heavy turning department, on the opposite side of the shop and at the front end, contains all lathes of 28-inch swing and upwards. Also, the heavy turret lathes for cast iron work and the larger parts of steel or other material. Here are also the vertical chucking machines, which are in many cases to be preferred to those of horizontal type. The lathes of 38-inch swing and upwards are placed inside of the row of columns so as to be served by the traveling crane. Nevertheless, small jib cranes attached to the columns and operated by hand will be found very useful for a number of the other machines. The cone-turning machine should be arranged to turn and crown all the steps of a cone at once. This and the pulley-turning machine are located convenient to the vertical chucking machines. Two shafting lathes of 28-inch swing and 44-feet beds are provided. In locating the lathes a space of four feet is left between the ends so as to give free access to any part of the room. Material is brought in on the tram track, one end of which extends out under the traveling crane. The heavy turret lathes and the vertical chucking machines will handle much of the work frequently done in the engine lathes and do it much quicker, thereby saving the number of the latter to be set up.

Next in order is the Milling and Gear Cutting Department. Here surface milling machines are provided for large surfaces, while smaller surfaces are taken care of by the six plain, or Lincoln millers. Two universal millers do the more complicated work and a small lathe is put in as a convenient machine to save going to another department for small and simple jobs of turning. The five vertical millers will do a large quantity of work very accurately and a better advantage than planers could do it, and at the same time at a much less cost for labor, as is the usual result with milling machine work. Six gear cutters are provided for spur gears, and two for bevel gears, while a special gear shaper and a gear planer will do the work required to be particularly accurate. Four rack cutters will usually be a proper proportion to the above. While the cutters for these machines are made in the general tool room, two grinders are provided so as to keep them in order in the department where they are used.

A convenient extension of the rear tram track furnishes means to bring in and take out work.

The gallery floors are divided into six departments, namely, Small Parts, Grinding, Polishing, Small Parts Assembling, Small Parts Store, and Experimental Departments. A tram track connects them all, passing through the cross gallery at the front end, under a traveling crane, by which any machine, car, truck, or lot of stock may be quickly transferred to or from the main or ground floor.

The Small Parts Department is the largest of the six and contains six turret lathes for making steel work from the bar, and four automatic screw machines for smaller work and for such special screws as may be made in the shop more economically than they can be purchased. A line of engine lathes of the sizes given on the plan handle such small work as requires to be turned on centers. Long lathes for turning and threading leadscrews and similar work are provided, as is also a machine with a traveling head for milling the splines in long rods or screws, and two small key-seating machines for milling semi-circular key seats. Racks for bar stock are provided in the front gallery and near the screw lathes for stock and for finished work.

The Grinding Department and the Polishing Department are for obvious reasons placed as far from the other work as possible. Much of the cylindrical work is sent to the grinding room to be reduced to perfectly cylindrical form on wet grinders and does not require any polishing finish. For this work three large, two medium and eight small grinders are provided. One large and two small dry surface grinders are arranged to take such small parts as require this treatment.

The Polishing Department as now known in connection with a machine shop is somewhat new in this class of machine work, but its importance and efficiency is becoming more recognized as its usefulness is being demonstrated. Four disk grinders or polishers are provided for small or medium sized flat surfaces, and work direct from the planers is quickly polished to a fine finish and quite true. Three speed lathes are expected to do all the small cylindrical work that has not been ground. Work requiring a bright buffed finish is taken to the four buffers, while irregularly shaped parts are polished on the three polishing heads or on the two belt, or strapping machines. This room, of course, enclosed as tightly as possible to avoid the difficulty of floating particles or grinder's dust passing to the other departments. Nearly all of this trouble may be prevented by a small exhaust fan connected with hoods at each of the machines by a suitable main pipe and branches, by which the dust is discharged in the open air, or a proper receptacle. This has the additional advantage of saving the eyes of the workmen from much annoyance and discomfort.

Small parts when completed are taken to the Finished Parts Store Room, which is located in the front end of the shop and furnished with shelves arranged in alcoves on one side of the room, while the opposite side is reserved for somewhat larger parts or collections of parts as may be necessary. This space should be fitted up to suit the particular kind of work, and may be in broad shelves running lengthwise of the room, or in alcoves as on the opposite side.

Between this room and the grinding department is the Small Parts Assembling Department, in which it is intended to assemble groups of small parts, as for instance, the parts comprising the apron of a lathe, or similar work. If the parts are accurately made no machine work will be here needed, although a small engine lathe might be a convenience at times. Bench vises and the usual assembling "jacks" comprise most of the necessary fittings.

In the back end of the opposite gallery is located the Experimental Department, where small and medium sized experimental work is to be done. It contains, as will be seen in the plans, a variety of machines suitable for experimental work, so as to render it unnecessary to go to any of the other departments for anything except large turning, planing and gear cutting. Such a department is a necessity to a shop aiming at making progress and keeping up with the times, as work of this character costs too much if done in the regular tool room, and it is not only an awkward but expensive matter to place it in any other department.

Along the front of each gallery is an iron railing 32 inches high, that on the front end gallery having an easily removable section 12 feet in length, for convenience in passing work to and from the gallery by the traveling crane.

The Foremen's Offices, the Tool Distributing and the Finished Parts Store Room are sheathed up with ⅞-inch pine to the height of 44 inches, above which it is enclosed with wire netting of 1-inch mesh and 4 feet in width. This form of construction affords an ample enclosure and does not materially impede the light. The doors should be provided with spring locks, and workmen generally not allowed in these enclosures except by permission.

* * *

A MODERN OFFICE BUILDING.

The accompanying cuts show the new office building lately completed by the American Blower Co., Detroit, Mich. The building is devoted entirely to the company's offices and is a model of convenience and unusually attractive in appearance. It was intended that the building should represent the highest development in office construction, both architecturally and in its heating and ventilating and other equipment. It is from designs by Malcomson and Higginbotham, Detroit, in adapted Colonial style.

The building is faced with standard size paving brick in various shades of brown, laid in dark mortar and with Flemish bond. The trimmings are of buff Bedford limestone and plate glass windows give the best possible lighting effect, especially in the drafting room. The broad pilasters and heavy cornice in front give an imposing appearance.

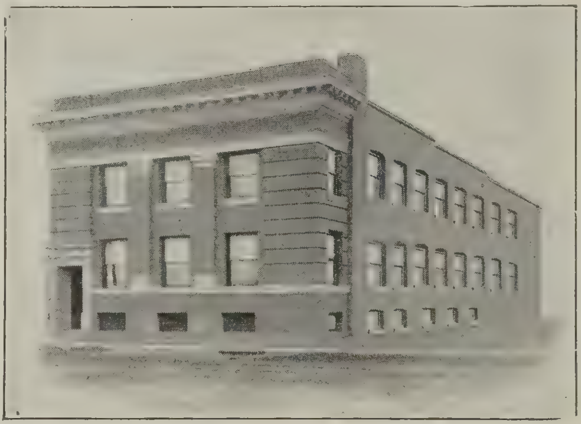


Fig. 1. Office Building of American Blower Co.

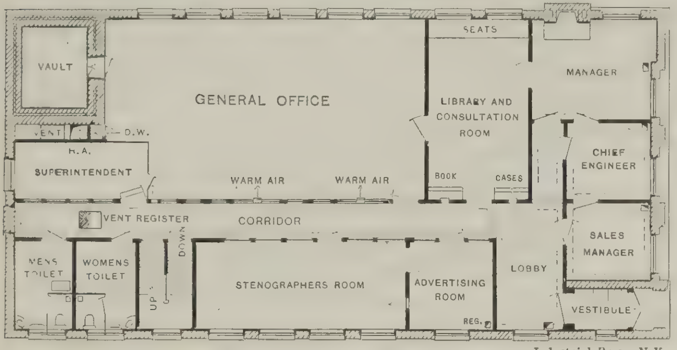
The first floor is occupied entirely by the different commercial departments, while the second floor is used by the engineering and drafting departments. The basement is used for the storage of catalogues, letter files, etc. A small building on the roof is used for blueprinting, and as a dark room.

The interior finish of the first story is Flemish oak with natural oak floor. The second story is finished in stained Louisiana cypress with maple floor, which affords a pleasing contrast. The decoration of the library and consultation room is more elaborate and includes a wainscoting, decorative frieze, and wood cornice, in harmony, however, with the general design of the building.

Every modern equipment is provided for the building, including electric lights, annunciator bells, dumb waiter, an outside telephone system, and an independent inside or house system connecting all departments in office and shops.

The main interest in the equipment, however, is in the mechanical system of heating and ventilation. As the manufacture of heating and ventilating apparatus forms a large part of the American Blower Company's business, this part of the office equipment naturally received due attention, and an even, pleasant temperature and thorough ventilation are secured without drafts.

The apparatus is located at one side of the basement, as shown in the accompanying plan. The fresh air enters the building through the basement window *F* and by means of the fan *A* is drawn over a coil of pipes *E*, called the tempering coil. The steam pipes of this tempering coil are just sufficient in number and length to heat the volume of entering air to a temperature of 65 or 70 degrees F. The fresh air is then drawn into the fan and forced over another heater *D*. This is the main heater and is designed to heat the air to about 140 degrees. Beyond the heater is located a large brick chamber *G* called the plenum chamber. This serves as a reservoir for the heated air and from this chamber the air is conveyed by galvanized iron pipes *H* to the various offices. Under the main heater *D* is a passage or by-pass as it is called, which permits a part of the air from the fan to pass under the main heater coil and into the plenum chamber. This passes into the lower section of the plenum chamber, which is separated from the upper part. Thus the plenum chamber is divided into two parts, the upper chamber containing hot air at approximately 140 degrees and the lower section tempered air at 70 degrees. As shown by this sectional view, each individual pipe leading off to the offices above, has two connections to this plenum chamber, one branch to the upper section and another to the lower. In each main where the pipe divides into these two sections, there is located a set of double swinging dampers, or mixing dampers. Each set of these dampers is controlled automatically by a diaphragm valve which is part of a system of automatic heat control furnished by the Johnson Electric Service Company of Milwaukee, Wis. These valves are operated by compressed air, which is supplied by a small air compressor, located in the basement, and operated by city water pressure. In each office is located a thermostat which can be set to control the room temperature at any desired point. These thermostats work upon the principle of the unequal expansion and contraction of brass and steel, and are all connected by head pipes, of about ⅜-inch bore, with their respective diaphragm valves. On the expansion or contraction of a piece of brass and steel in the thermostat, air pressure is admitted or cut off from the diaphragm valve and the mixing dampers are swung one way or the other as the case may be. It will be noted that these mixing dampers in swinging do not cut off the flow of air, but simply vary the proportion of hot and tempered air as controlled by the thermostat to maintain a constant temperature in the room. Thus a constant flow of pure air of the proper temperature is maintained at all times. Under the tempering coil there is also a by-pass similar to the one under the main heater. This by-pass is fitted with a swinging damper which is controlled by a thermostat placed in the upper part of the plenum chamber. Thus if the air in the plenum chamber becomes too hot, the thermostat opens the damper under the tempering coil and allows the entering air to pass under the tempering coil, instead of through it. The air is admitted to each room at a point about eight feet above the floor.



Industrial Press, N.Y.

Fig. 2. First Floor Plan.

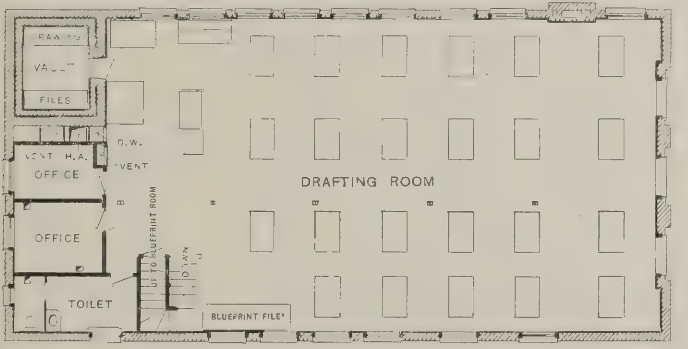


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Fig. 3. Second Floor Plan.

Another unique feature of this plant is the exhaust fan which is direct coupled to the same engine which runs the heating fan and which draws the impure or vitiated air out of the building. Thus while one fan is discharging pure warm air into the building, the other fan on the same shaft is drawing out the impure air. This is the main feature of mechanical ventilation which has brought it into such general favor during the last few years for use in public buildings.

In each office on the first floor there is located an ornamental register face at the floor line, opening into the corridor which extends through the center of building. The air is thence drawn down through the large register in the floor at the rear of the corridor and after passing through the exhaust fan is forced outside the building. The air from the drawing room and second story offices is drawn through the flue at side of vault.

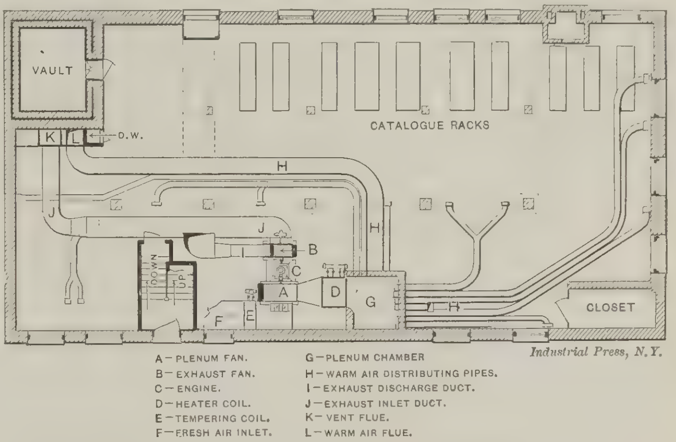

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Fig. 4. Basement Plan, showing Heating and Ventilating Apparatus.

The condensation from the heating apparatus is returned to a Webster feed-water heater located in the engine room of the factory, by means of the Webster vacuum system which was furnished by the American Engineering Specialty Co., of Chicago. This same system handles all the condensation from two other heating plants located in the factory. The advantage of this vacuum system is that it eliminates the back pressure from the factory engine, when using exhaust steam for heating and also removes the air from the heating coils and connecting pipes as fast as it accumulates, thus making the heating surface far more effective than it otherwise would be.

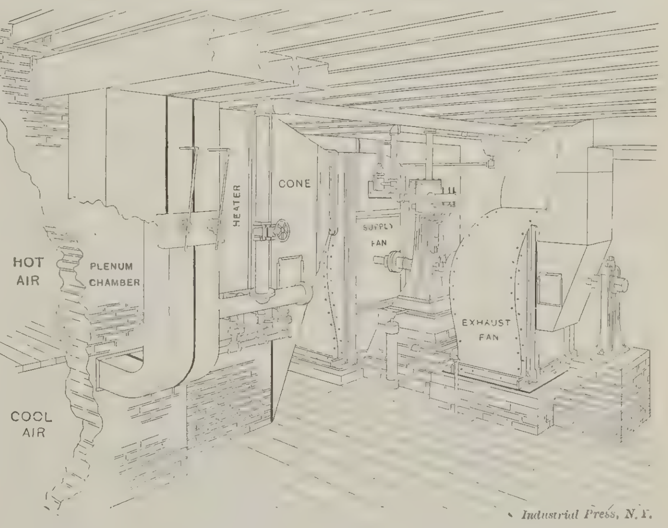

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Fig. 5. General View of Heating and Ventilating Apparatus.

Only one thing remains to be mentioned and that is the economy of this system. As the heating coils utilize the exhaust steam from the factory engine, which is brought into the basement through an underground conduit, and as the fan engine exhaust is also turned into the heater coil, the cost of operating is very small, and in fact practically nothing under the conditions, as the steam that is used for heating, would otherwise probably be wasted.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

SEPTEMBER, 1903.

NET CIRCULATION FOR AUGUST, 1903,—24,893 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

A NEW OLD ENGINE.

Several technical journals have recently published descriptions of an alleged new rotary steam engine, the principle of which, in its simplest form, involves the use of two revolving cylinders or wheels mounted on parallel shafts and working inside of a closely fitting case. One of the cylinders carries teeth, preferably two, which engage the same number of tooth depressions in the opposing cylinder. Both cylinders are geared so as to rotate in opposite directions and at the same peripheral speed, gears of the same diameter being keyed to the shafts outside the casing. This is necessary because the cylinders themselves are mutilated gears and can only transmit motion one from the other when the teeth are in engagement with the tooth spaces. Steam admitted into one side of the casing tends to rotate the cylinders, since the pressure on one tooth is unbalanced, the other tooth being shut away from the steam pressure by the periphery of the other cylinder. It is clearly obvious to anyone at all familiar with the construction of steam, air and water motors—especially the large class known as rotary engines—also with positive pressure blowers, that the principle is anything but new. The device in question is simply a modification of the well-known Roots blower used for iron foundries, etc. But we can go way back of this invention and find one very similar. Seth Boyden of malleable iron and patent leather fame, invented a steam rotary engine working on the same principle, although not employing mutilated gears, and was granted a patent for the same October 31, 1831. In the description of the invention the following appears:

"Two teeth wheels are placed with their axles in sockets or supporters parallel and horizontal to each other and close together as the teeth will play free. The whole is inclosed in a case of cylindrical form, which holds pieces termed packing against the ends and opposite sides of the wheels to prevent the steam from passing the wheels without acting on them. This packing is pressed to the wheels by screws to close the vacancy made by wear. The steam is applied to the under side of the wheels, pressing forward on the teeth of each wheel opposite to each other, causing a rapid rotary motion, while the teeth on the side next each other from the pressure of the steam. In this situation the steam presses outward on a surface equal to the depth and width of two teeth while the teeth come in behind each other, exposing the surface of only one, giving a power equal to the pressure of the steam on the tooth of one wheel. A connection is made to one of the axles through the case to communicate their motion to whatever it may be applied."

* * *

The application of electricity as a motive power for machine shops has been an evolution rather than a revolution, and, except in special instances, its use is steadily superseding that of steam, compressed air, hydraulics, rope drive, or combinations of these powers. In the past ten years the use of electric motors in shops has risen from a few incomplete and scattered cases to the present employment of about 600,000 H. P. regularly supplied by electricity.

A large manufacturing concern states that exclusive of those used for railways, automobiles, elevators, and fans, there are over 60,000 motors, ranging from 1/8 H. P. to 2,000 H. P., in daily operation in the United States, supplying over one million horse power, and representing an investment of about twelve million dollars.

It is recorded that in one instance where thirty steam engines of 1,375 total horse power were supplanted by fifty-seven motors of 1,065 total horse power, for machine shop driving, the average daily saving in steam was 41.6 per cent., of combustibles 32.2 per cent. (coal saved 20,000 pounds). In other cases electric driving has reduced by 50 per cent. the cost for engineer, coal, and water; the fuel account 20 per cent., the cost of power 44 per cent. The gross saving was 30 per cent. with direct connected motors, and 22 per cent. with belted or geared motors.

* * *

SYSTEMATIC PRESENTATION OF PAPERS.

In arranging for the recent meeting of the American Institute of Electrical Engineers at Niagara Falls a plan was adopted that was productive of good results and that we would commend to the American Society of Mechanical Engineers as a desirable means for enhancing the value of papers presented at its meetings. The plan consisted in placing in charge of a member who is a specialist in a given subject the preparation of a programme of papers on that subject. The result is a much more complete presentation of the topic under discussion than would be possible in any other way. It is of the greatest advantage to engineers to have complete data gathered in one place for convenient reference, and the subject treated from several different standpoints. It is seldom that an author can write comprehensively from his own experience alone, and a man seldom has time or opportunity to draw information from various sources and to present a paper giving a broad and general view of a subject. Such papers have been given at meetings of the A. S. M. E., notably by Prof. Thurston, on topics like superheating, steam turbines, etc. But as a general thing any single paper is more likely to either give the results of one man's experience or else to be more or less one-sided in its treatment. By having several related papers, however, written in accordance with a general plan outlined by a competent authority, they would be of greater value to all concerned, just as they have proven to be in the case of the Institute of Electrical Engineers.

Should it happen that a subject were to be treated on which there were very few available data, the plan would still work out well, for the person in charge could outline a series of tests which various colleges would doubtless be glad to carry out and the work would thus be conducted on a systematic basis. It is usual, under the present order of things, for a college laboratory to undertake a series of experiments so extensive that it is impossible to complete them in any reasonable time, and in consequence they do not bring out the points upon which information is desired in anything like a complete manner. It would be an improvement if some of these tests, at least, could be under the guidance of one central ruling hand.

* * *

This number of Machinery begins the tenth volume of the paper. A copy of the index for the past year will be sent free to any subscriber asking for it, and in writing kindly state whether the index for the Shop Edition or for the Engineering Edition is desired.

THE GAS TURBINE.

In connection with a discussion on the steam turbine at the Master Mechanics' convention at Saratoga, Prof. Hibbard of Cornell University announced that there were prospects of developments in the field of the gas turbine at the General Electric Company's works, Schenectady. A gentleman, who recently received an advanced degree at a Western university in virtue of a very thorough investigation on the subject of the gas turbine, is now in the employ of the General Electric Company, and the inference is that he will have at his disposal the extensive facilities of this company for conducting experiments that may eventually lead to a successful gas turbine. This gentleman is Mr. Sanford A. Moss, who has made a special study of the subject of gas turbines since 1898. He received the degree of Master of Science at the University of California and has also studied at Cornell University, specializing upon the same subject—that of the gas turbine.

The great thermodynamic advantage of the steam turbine over the steam reciprocating engine is that there is no condensation and re-evaporation through contact with metal surfaces which are alternately heated and cooled. The only condensation in a steam turbine to amount to anything comes from the conversion of the energy of the steam into work. In the gas turbine there is, of course, no condensation to enter into the question, but there is an opportunity for another and more important gain through the abolition of the water jacket. It is a singular fact that the turbine is theoretically and probably practically capable of effecting a saving over the reciprocating engine, whether used with steam or with heated air, but because of entirely different reasons in each case.

It is well known that the efficiency of the gas engine depends mainly upon the degree of compression pressure attained in the working fluid. When operating upon the Otto cycle the gas and air are compressed to as great a pressure as practicable and then are exploded, giving a still higher pressure. This same process can be employed in connection with a gas turbine and has been advocated for that purpose. Under this plan the air and gas would be compressed and exploded in a chamber lined with refractory material, and would then discharge through a diverting nozzle and impinge against the blades of a turbine wheel, as in the case of the De Laval steam turbine. The diverging nozzle would act as an expansion nozzle, to reduce the pressure of the gases to atmospheric pressure and convert their potential energy into kinetic energy before doing work upon the wheel. The discharge would occur in puffs, an impulse being given as often as an explosion occurred.

Another method of accomplishing the result would be to have the combustion element burn continuously in contact with compressed air in a refractory chamber from which the heated air would discharge continuously through the expansion nozzle. The pressure in the chamber would remain constant under such conditions and the question of efficiency of the apparatus would depend solely upon the pressure that was attained through compression, as the relative amount of work done in an engine working upon this cycle does not depend upon the temperature of combustion. The efficiency of this cycle is not as high as that of the Otto cycle, but for turbine purposes would have the merit of giving continuous discharge through the nozzle instead of intermittent discharge. This plan of compression and then heating under constant pressure was employed in the well-known Brayton petroleum engine, one of the pioneers in the gas engine field.

The perfection of the gas turbine will not be an easy proposition. It will either have to be accomplished by individuals, working in a hap-hazard way through a long period of years, or by the concentrated efforts of some large firm like the General Electric Company. The latter plan will undoubtedly result in the quicker solution of the problem. One of the problems will be that of the temperature of the gas and its effect upon the metal of the turbine wheel. While the hot air will not come in contact with any of the bearings of the wheel, it is evident that the blades might not stand up to their work if subjected to a very high temperature. The fact that all bearings and wearing surfaces, however, would be removed from contact with the hot gases, would undoubtedly make the water jacket unnecessary.

HIGH-SPEED STEEL.

Practically all the makers of tool steel in this country and in Europe appear to have brought out under some fancy name a so-called "high-speed steel." Most of these steels, if not all of them, depend upon the influence of tungsten, chromium, molybdenum, titanium, etc., together with the heat treatment to produce a peculiar steel alloy which is actually harder when hot up to, say, a low red with some brands, than when cold. In fact some makes of high-speed steel can be filed when cold after they have once been used. Almost any one of these steels seems to be able to accomplish wonders when manipulated by its friends, but in the hands of the average user there is a variety of experience—good, bad, and indifferent—which indicates a great degree of variation in the same brands of steel, and it also shows the want of adaptability in toolsmiths to handle them. This latter is often the prime cause for want of success. The whole training of most toolsmiths has been to give them a horror of overheating tool steel, but many of the high-speed steels must be forged at a white heat. In fact the attempt to forge at the heat ordinarily employed on tool steel will result in failure. One brand we know of must be heated until the steel drips at the point and is then dipped in oil—pretty severe treatment, but it must be followed to get the maximum efficiency. Again there is all the difference in the way a comparative test of different brands is made. Suppose that one maker has sent a sample of comparatively small section and another has sent a larger and heavier section. The small section is at a disadvantage for slow speed and a heavy cut, as it does not have the strength to resist vibration; but at high speeds and light cuts it will ordinarily show up better than the heavy section, as its temperature will rise to nearer the effective working degree. The point is that almost all the leading brands have a critical working temperature which lies within comparatively narrow limits. The best results with high-speed steels are obtained in those shops which have selected some one brand and have stuck to it. They have gotten their toolsmiths and machine men educated to the peculiar characteristics of the brand used and know how to handle it. A change to another brand is usually unsatisfactory all around.

* * *

LEAFLETS AS SUPPLEMENTS TO CATALOGUES.

A practice that is coming into vogue with some machine tool builders, is to have cuts and descriptions of their various machines printed on loose leaflets of the same size as their regular letter paper sheets, one machine and description appearing on a leaflet. Whenever an inquiry is received regarding a particular machine, the letter of reply is accompanied with a leaflet, in the same envelope, giving the cut and description. This practice insures that the party receiving the letter will also get the description which he often fails of in some offices, because of the careless treatment accorded catalogues and other advertising literature in general. The practice is one highly thought of by purchasing agents of railways and large concerns. It saves them much valuable time in wading through catalogues, and it puts the desired data in convenient form for filing along with the letter quoting price, date of delivery, etc. The leaflets may be perforated for filing in a loose-leaf binder, but this is not essential as they are not intended to take the place of the regular catalogues, but are only supplementary to them.

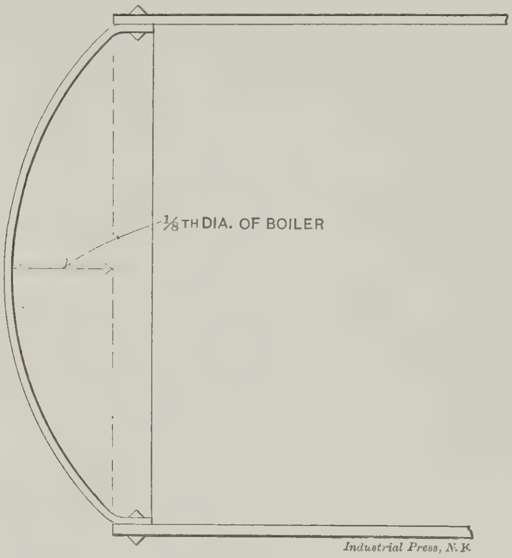
* * *

In a paper upon the gaseous fuel problem read by Mr. Henry G. Morris before the Engineers' Club of Philadelphia, a strong argument is made for the development of by-products coke ovens. Taking figures for the bee hive ovens between Altoona and Pittsburg, we find that 20,000 tons of coke are produced per day, from which about 100,000,000 cubic feet of gas discharge into the air. This gas, if converted into power through gas engines, would represent 5,000,000 horse power hours, or the effort of about 104 gas engines of 2,000 horse power each. Manufacturers of gas apparatus are now offering to guarantee the production of a horse power hour for one pound of fuel—a result not at present attainable through the medium of steam engines and boilers, except by the most complex type of engine.

BOILER BRACING.—1.

CHARLES L. HUBBARD.

In laying out the braces for any given boiler the first step, whatever the type of brace to be used, is to determine the bounding lines of the area to be supported. From tests made it has been found that a steel tube two inches in diameter and of standard thickness will resist a pull of from 15,000 to 20,000 pounds, so that in the case of a cylindrical boiler only that portion of the heads above the tubes need to be considered in laying out the braces. If a boiler head could be made convex or "bumped up" to the extent of one-eighth of its diameter, as shown in Fig. 1, it would be as strong as any portion of the shell, provided it was of the same material and thickness. It would be very difficult, however, to connect the tubes with such a head, so flat heads must be used and the pressure above the tube line must be carried by stays or braces.



Industrial Press, N.Y.

Fig. 1.

In determining the area to be supported it is customary to consider the lower edge as bounded by a line drawn through the upper row of tubes, at a distance equal to one-fourth their diameter below the upper edge (see *A C*, Fig. 2). The remaining boundry line is evidently that formed by the upper part of the boiler shell. It does not follow, however, that the whole of this enclosed area must be supported by the braces, because when the head is flanged and riveted to the shell a portion of it becomes stiff enough to carry the pressure independently of the braces. The distance from the shell that it becomes self-supporting may be determined by the following formula:

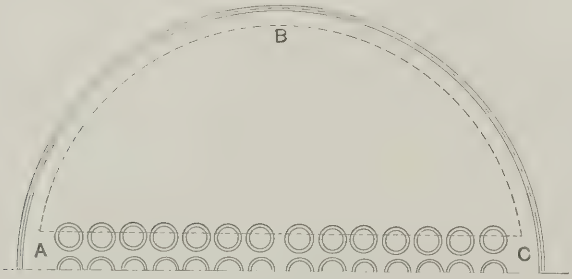


Fig. 2.

$$D = \frac{4484 \times T}{10 \times P} + .5, \text{ in which}$$

$D =$ the distance in inches.

$T =$ the thickness of the head in inches.

$P =$ the boiler pressure to be carried.

Refer to the diagram, Fig. 3.

Having determined the value of D for any given case the line *A B C* may be drawn in, giving us the area to be supported by the braces. If some form of diagonal brace is to be used, the number will be determined both by the size of the brace and the area to be supported. In case any of the solid steel braces like the McGregor or Huston are used the size of the brace will in general be fixed, and the number must be made such as will safely carry the total load upon the unsupported area. If crow-foot braces are used the size, and therefore the number may be varied somewhat. The actual supporting points are the rivets attaching the stays to the heads, and the spacing of these will depend upon the thickness of the plates and the pressure to be carried. The allowable maximum distance between the supported points may be computed by the formula

$$p = \sqrt{\frac{C\,t^2}{P}}, \text{ in which}$$

$p =$ the greatest allowable pitch in inches.

$t =$ the thickness of the plate in sixteenths of an inch.

$P =$ the working steam pressure carried on the boiler.

$C = 112$ for plates 7-16 inch and under.

$C = 120$ for plates over 7-16 inch.

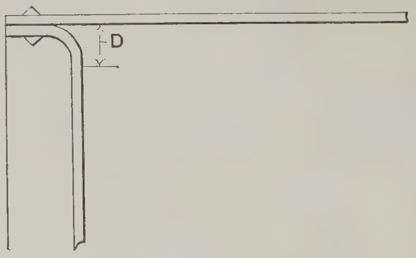


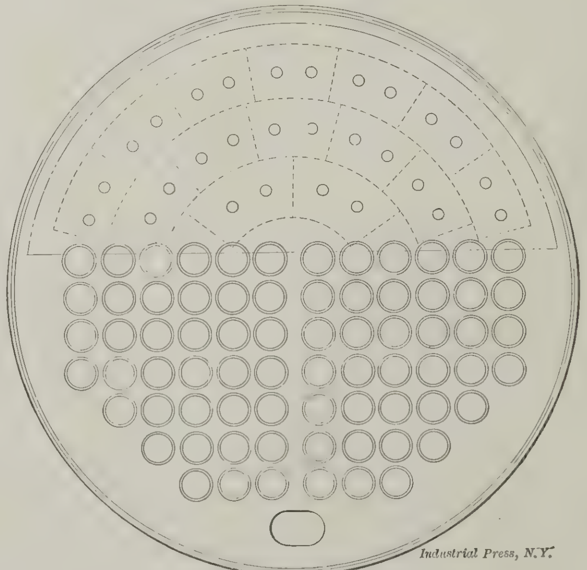
Fig. 3.

This applies only where the supported points are in equidistant rows, both vertically and horizontally. When the rows are not equally spaced, the greatest distance between supports may be taken for the value of "p," which will give a safe result in all cases.

In order to know the total load to be carried by the braces we must first compute the area of the supported portion and multiply it by the boiler pressure.

The area of this segment may be obtained from a table which can be found in almost any engineer's hand book, or may be computed in the following manner:

Carefully measure on your drawing by the means of a pair of dividers, the arc *A B C* (see Fig. 4), and multiply the same by one-half the radius of the circle. This will give the area of the sector *O A B C*; deduct the area of the triangle *O A C* and the result will be the area of the segment, *A B C*.



Industrial Press, N.Y.

Fig. 7.

In crow-foot bracing the supporting points are usually arranged in sets of four, and are fastened to forgings known as "crow-feet." A diagonal stay with a forked head and pin connects each crow-foot with the boiler shell, to which it is fastened with two or more rivets.

A crow-foot joined to the boiler head with four rivets is called a double crow-foot, while if only two rivets are used it is called a single crow-foot. Single and double crow-feet are shown in Figs. 5 and 6, respectively. In the design of crow-foot bracing that portion of the head enclosed within the segment is marked off in points to be supported, the distance between these being limited by the value of "p" as found by the preceding formula. The points are then taken in groups of two or four as desired and tied to a crow-foot by rivets. (See Figs. 7 and 8.)

The load to be supported by any one brace is that due to the steam pressure acting on an area bounded by lines drawn on the four sides of the chosen group of rivets, halfway between them and the adjacent groups or other points of support as the case may be. (See Fig. 7.) The rivets should be spaced so that the total load will be divided among the different braces as evenly as possible. It is customary to compute the size of the brace carrying the greatest load, and then make the others of the same size for uniformity.

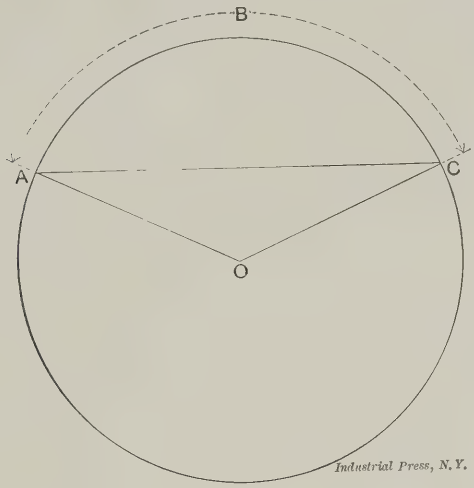


Fig. 4.

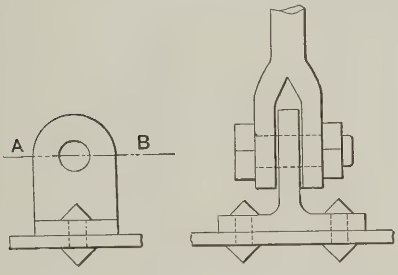


Fig. 5.

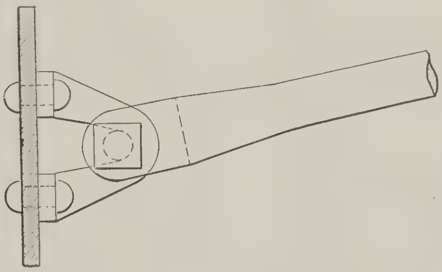


Fig. 6.

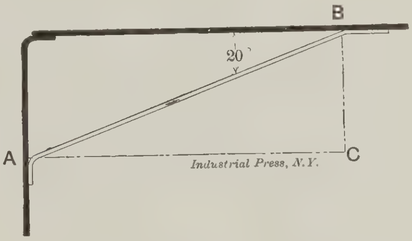


Fig. 10.

To find the size of rivets required divide the total load carried by the brace by the number of rivets in the crow-foot, to find the load on a single rivet and make the diameter such that the stress shall not exceed 6,000 pounds per square inch for steel. The diameter of these rivets should not in any case be less than three-quarter inch in diameter, owing to internal strains set up by riveting. The length of the bolt or pin between the supports is so short that the principal stress to be considered is that due to shearing; but for safety it may be checked for crushing effect and also treated as a uniformly loaded beam supported at both ends. Resistance to crushing may be taken as 15,000 pounds for steel, and 12,000 for wrought iron.

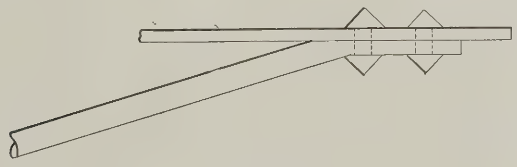


Fig. 9.

The pin being supported at both ends is in double shear, and we may assume a working stress of 14,000 pounds per square inch for mild steel, which is the material commonly used.

If it is treated as a beam the maximum bending moment, $M = \dfrac{WL}{8}$ in which W is the total load on the pin, in pounds, and L the distance between supports in inches.

The "section modulus" for a section of circular form is

$$\frac{\text{area} \times \text{diameter}}{8}$$

We know from "mechanics" that

$M = R f$ in which

M = maximum bending moment,

R = section modulus, or moment of resistance,

f = maximum stress in outer fiber of the bar.

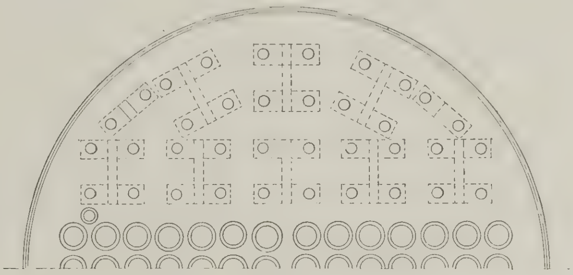


Fig. 8.

Substituting the values of M and R in the equations, and transposing we have

$$f = \frac{W L}{\text{area} \times \text{diameter}}$$

in which f should not exceed 12,000 pounds.

The crow-foot being a forging should not carry a load of much over 5,000 pounds per square inch of section at its weakest point.

The stays or braces are made of wrought-iron, as the fork which is attached to the crow-foot must be forged to shape. While wrought-iron should safely carry a load of from 7,000 to 8,000 pounds per square inch, the fact that the brace contains one or more welded joints makes its strength somewhat uncertain and it is well not to count on much over 5,000 pounds. The end which is attached to the shell is flattened, and riveted in place, usually with two rivets, which may be of the same diameter as the pin, though never less than ¾-inch (see Fig. 9). The angle which the brace makes with the boiler shell should not in general be greater than 20 deg. Referring to Fig. 10, it will be seen that the pull in the direction of the brace is greater than the load which it supports perpendicular to the boiler lead, in proportion to the lengths of the lines $A\,B$ and $A\,C$. If the brace makes an angle of 20 deg. with the shell, we must multiply the load to be supported at the head by 1.07 to obtain the pull on the brace, and the required diameter must be proportioned accordingly. For different angles multiply by the following factors:

Angle.	Factor.
14 deg.	1.03
16 deg.	1.04
18 deg.	1.05
20 deg.	1.07
22 deg.	1.08
24 deg.	1.10
26 deg.	1.11

The common form of crow-foot and forked brace is being quite largely superseded by the various forms of solid steel braces, two of which are shown in Figs. 11 and 12. As this type of brace is of steel and has no pin to shear or weld to prove defective, we can count on a much higher tensile strength. As these braces come in stock sizes, having usually one square inch of sectional area after deducting that cut away by rivet holes, the method of determining the number of braces is somewhat different from that already described. In this case we must first compute the area of the portion of the head to be supported and multiply it by the steam pressure, to get the total load. A solid steel brace should safely carry 10,000 pounds per square inch of section. From this it is evident that the total load divided by 10,000 will give the total cross section of the braces, and this divided by the sectional area of a single brace of the type to be used will give the number required. If the area to be held by the braces was in the form of a square it would be possible to locate them so that the exact number determined by a theoretical calculation could be used satisfactorily. But the space on the heads is in such form that this cannot be done, therefore it is necessary to put in enough braces to amply protect the whole, making the number actually required greater than the number determined by the calculation, as in some cases they must be nearer together than the area exposed to pressure calls for. As this adds to the strength of the boiler there can be no objection to it. After the braces are all located, the greatest distance between rivets should be measured and the strength of the head checked by the methods already given.

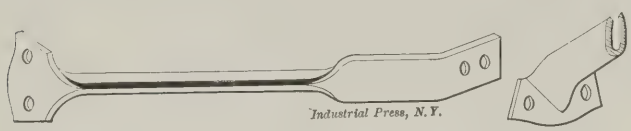


Fig. 11.

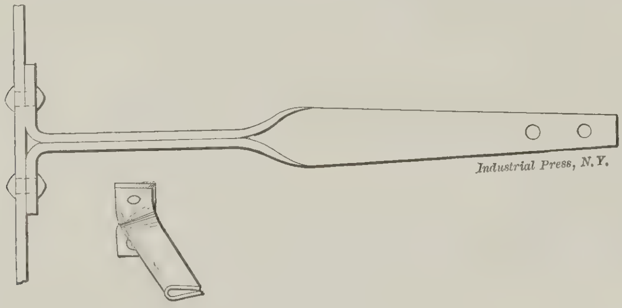


Fig. 12.

A future article will take up the design of "through bracing" and combinations of through and crow-foot bracing.

* * *

MECHANICAL DRAWING AND THE SHOP.

In an address before the Eastern Manual Training Association's convention, held at Boston in July, Mr. L. D. Burlingame chief draftsman of the Brown & Sharpe Mfg. Co., Providence, considered the subject of mechanical drawing and its relation to practical shop work. He said that the drafting office has three distinct functions to fulfill. First, it must be an interpreter *to* the shop; second, an interpreter *of* the shop; and third, a recorder *for* the shop. There was a time when the designer, who had a rough conception of what he wanted to build, stood over the patternmaker until some box-like patterns were produced. With these as a skeleton to build on, the inventor continued to work out his design from "hand to mouth," cutting, changing, discarding, until the desired end was attained or until it was found necessary to start again. Now all this is changed and every piece must be fully and separately detailed, in many shops each on a sheet by itself, all particulars of oiling and venting oil holes, must be shown, grinding limits given, the depths of tapped holes figured. There must be an indication of where stock is to be allowed for fitting, and of the special kinds of finish on machined surfaces. All special tools used in manufacturing the piece must be listed below its name, and perhaps a list of operations given either on the drawing or in a separate list, and so on until it would seem that little was left for the machinist to do but to follow the instructions on the drawings without thought, or the use of his judgment. This may seem so to the draftsman, indeed it seemed so to me at one time, but when, after having a number of year's experience as draftsman, I went into the shop to work, I soon learned otherwise and felt like changing Hamlet's words: "There are more things in heaven and earth, Horatio, than are dreamt of in our philosophy," to read, "There are more things in the machine shop and foundry to learn, than are dreamt of in our drafting room." I have since had a growing respect for the machinist and for the importance of the problems *he* is daily called upon to solve.

In this office of interpreter *to* the shop the best results can be obtained by thorough system, by uniformity of practice, by condensing, by avoiding repetition, by keeping clear of complicated systems and unintelligible symbols. The drawings should be made to as large a scale as practicable, with figures and lettering bold and well separted from the lines of the drawing. All lines should be heavy for satisfactory blue printing. Pattern figures should not appear on the drawing but be marked in a blue print specially for the pattern maker, or in some cases a separate pattern drawing made. Third angle projection should be used in all cases for the sake of uniformity and directness. Finish should be indicated by some method that will not allow of misunderstanding.

On standard machines, each piece should be fully detailed. If on a sheet by itself, so much the better, it can then accompany the work through the departments of the shop and other work need not be held waiting for the drawings to use for other pieces on the same sheet. Stock parts should be used whenever possible and when used should be called for by a simple numbering system requiring but little clerical work and reducing the chance of error to a minimum. The drawings should be mounted for the shop on some suitable form of board. A thin metal plate with edges rolled as in tin work, to stiffen, makes a cheap, light mount and prints so mounted can be stored compactly. Orders should not be verbal, but should be written on printed forms and officially signed, books being used that produce multiple copies in such numbers as are required. All orders for new machines or tools should go through the drafting room before work is started in the shop. On standard lines of machines where lot after lot is built, some changes at least are required and these are often radical. In these cases drawings must be changed, records made complete, pattern lists revised, patterns altered or made new, and when all is ready, the shop notified. If urgent, the work can go along piece-meal as fast as ready.

There is a difference in practice as to whether the drafting department or the shop foreman should order castings, forgings and stock. In either case complete lists should be made up and kept corrected by the drafting department.

Before leaving this part of my subject I would emphasize the fact that the drawing is a means to an end and not the end sought; a point sometimes lost sight of by draftsmen and often lost sight of by technical students, a misconception for which the instructors may be sometimes responsible. It is natural no doubt in schools where making drawings is the work in hand, to make the drawing as such seem of paramount importance.

Admitting what has previously been said regarding the important place occupied by the machinist, you will also note the importance of the drafting department, as the interpreter *of* the shop. A friend of mine, one whose work has been unusually practical and successful, makes a constant practice of consulting with the machinists in whose judgment he has confidence, sometimes stopping his work and making a trip to a distant part of the works to get the shop man's opinion. It is not only the helpful suggestion that may come from such a conference, but the very statement of the case so plainly that it can be understood by another, may show to the designer a better plan, or show up a hidden fallacy. It is much better to have the suggestions and criticisms of the shop at the beginning when some benefit may result. Such consultations should be of much more frequent occurrence.

The drafting room should be so located as to be in the midst of the shop work if need be, even at some sacrifice of quiet and other advantages. It should also be in close touch with the pattern shop and foundry.

When making special tools, such as jigs, milling fixtures, etc., for reducing the cost of the work, the foreman or workman should not only be consulted but should usually have a deciding voice as to what should be made. He, having the tools to use, generally knows better than the draftsman what is needed.

The machinist and shop foreman being constantly with the work, know which are the expensive operations, when there is difficulty in fitting, where the clearances are so small as to often become interferences. They have the machines to repair when they are worn or broken. Then why should their suggestions or opinions be disregarded or looked upon slightingly? Why should the spirit be bred of antagonism and distrust, until the shop man will not make suggestions for fear he will be snubbed or that his idea will be appropriated without credit? It certainly should not be so. I believe that it is not so in well-managed American shops to-day.

When I was abroad at the time of the Paris Exposition of 1900, I visited many shops in France and England. My observation at the time led me to believe, and my opinion was confirmed by the experiences of others with whom I compared notes, that the class distinction between the owner, the engineer (or designer) and the draftsman, on the one hand and the shop man on the other, is much greater abroad, especially on the Continent, than with us. It is there considered beneath the dignity of a technically-educated engineer, to listen to suggestions from machinists. The results of this feeling are sometimes very costly. In our American drafting rooms there is, in my judgment, a constant improvement in this respect, perhaps due to the increased percentage of American and Americanized draftsmen, thanks to the good work of our technical schools. At the best, enough attention is not paid this important function of the drafting department; that of conserving and making available the valuable information held by the shop.

A method I have known to be used with excellent results is for each foreman and responsible workman to have a blank stub book with suitable printed headings, paged and numbered. In this he writes all suggestions, taking out the perforated leaf and sending to the chief draftsman, keeping the stub as a memorandum for his own use. These are sorted when received, and those requiring immediate attention put into the hands of the proper parties to investigate, others are filed under the respective machines until time to build another lot, when they are considered collectively. The workmen are not only at liberty to use these books but are held accountable if they allow troubles to exist, lot after lot, on the machines they build, and do not report them. I would earnestly recommend that there be instilled into the minds of technical students the importance of taking advantage of the great mass of mechanical knowledge and the ideas stored up in the minds of the mechanics of the country, in the minds of the men who are actually doing the work, and that the students have it impressed upon them that if they become draftsmen, one of their important duties will be so to get in touch with the shop, as to make this knowledge available even though it may come to them in crude form from a mind not trained to analyze, to classify, and to put ideas upon paper. In other words, that they learn to be the *interpreters of the shop*.

In considering briefly the office of the drafting room as the *recorder for the shop*, we touch upon some of the more hum-drum, though not less important work, of tabulating, listing and classifying. Let me illustrate: Many thousand special tools accumulate in a large shop. Prominent among these are taps, reamers, drills and counterbores, cutters, gages, etc. When new designs are under way, it should be the draftsman's duty to adapt the design as far as possible to use such tools as are at hand. To accomplish this a complete record of all such tools should be kept and it is to the drafting department that we should look for dong it in a thorough manner, so that the record can be quickly referred to and depended on when used by either draftsman or shop man.

To again illustrate: A gear index of all spur gear patterns available to use under ordinary conditions arranged in order first by pitch, then face, then diameter will quickly tell whether a pattern for the required gear is made. These illustrations might be continued indefinitely. The card index is a great aid to such classification, as all entries are in order.

Another form of tabulating is in figuring tables for the shop. The draftsman's familiarity with figures and facilities for doing such work, often by the aid of the slide rule or calculating machine, makes the drafting room the natural and economical place for it to be done. The figuring of a table of all leads than can be obtained on a milling machine, with the regular change gears furnished, will illustrate. Those that have had to do with the cutting of spiral gears will appreciate the value to the shop of such a table.

There are many things to be preserved for reference that naturally find their way to the drafting room, such as trade catalogues, photos, copies of patents and technical journals. The treatment of these in indexing makes all the difference whether they are valuable—of growing value as time goes on —or as worthless as so much scrap paper.

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UNIQUE HEATING AND VENTILATING PLANT.

An interesting heating and ventilating equipment was furnished the Twin City Telephone Co., St. Paul, Minn., some time ago, by the B. F. Sturtevant Co., Boston, Mass. In this installation special precaution was taken to purify the air supply. It has been demonstrated that about 90 per cent. of the trouble caused by imperfect contact in the switchboard connections can be prevented by thoroughly cleansing the air as it enters the building. Many experiments have been tried in the way of dry-cleaning by filtering through screens of wire and cheese-cloth or cotton-batting, but all such devices require frequent renewal, sometimes at considerable trouble and expense. By continued use any filter of this character must deteriorate and eventually become clogged, and in order to avoid the results of neglect it ought to be practically automatic. This point is essential in an air-cleaning system.

The action of the air-purifying and cooling apparatus adopted by the Twin City Telephone Co. consists in thoroughly saturating the air with water by passing it through a fine spray and afterward precipitating the moisture with the collected impurities and discharging it into the sewer. The water, which is taken up at high velocity and held in mechanical suspension, is extracted by centrifugal force by passing it through a series of tubes in which spirals are so placed as to give the air a whirling motion, causing the suspended particles, which are heavier than the air, to be thrown outward and brought in contact with the tubes, from which they flow through perforations to a drip-pan below.

The washing process imparts about 70 per cent. humidity at a temperature of 70 degrees Fahr. in the operating room. This is considered the most desirable for health and comfort and avoids the excessive dryness resulting with other systems of heating and ventilating which often require a humidostat to correct the defect. Moreover, in the summer time, with the temperature outside at 80 degrees Fahr. and with the normal temperature of the city water, the air delivered to the rooms can be readily reduced to 70 degrees.

The air after being tempered, washed and dried is blown by the fan through the reheating coils into the tempered air chamber. A mixing damper is placed with connections to both so arranged that the hot or tempered air, under the control of the Power's thermostat in the operating room, is mixed automatically to the proper degree, maintaining throughout the year a constant temperature in the room with uniform air delivery and humidity.

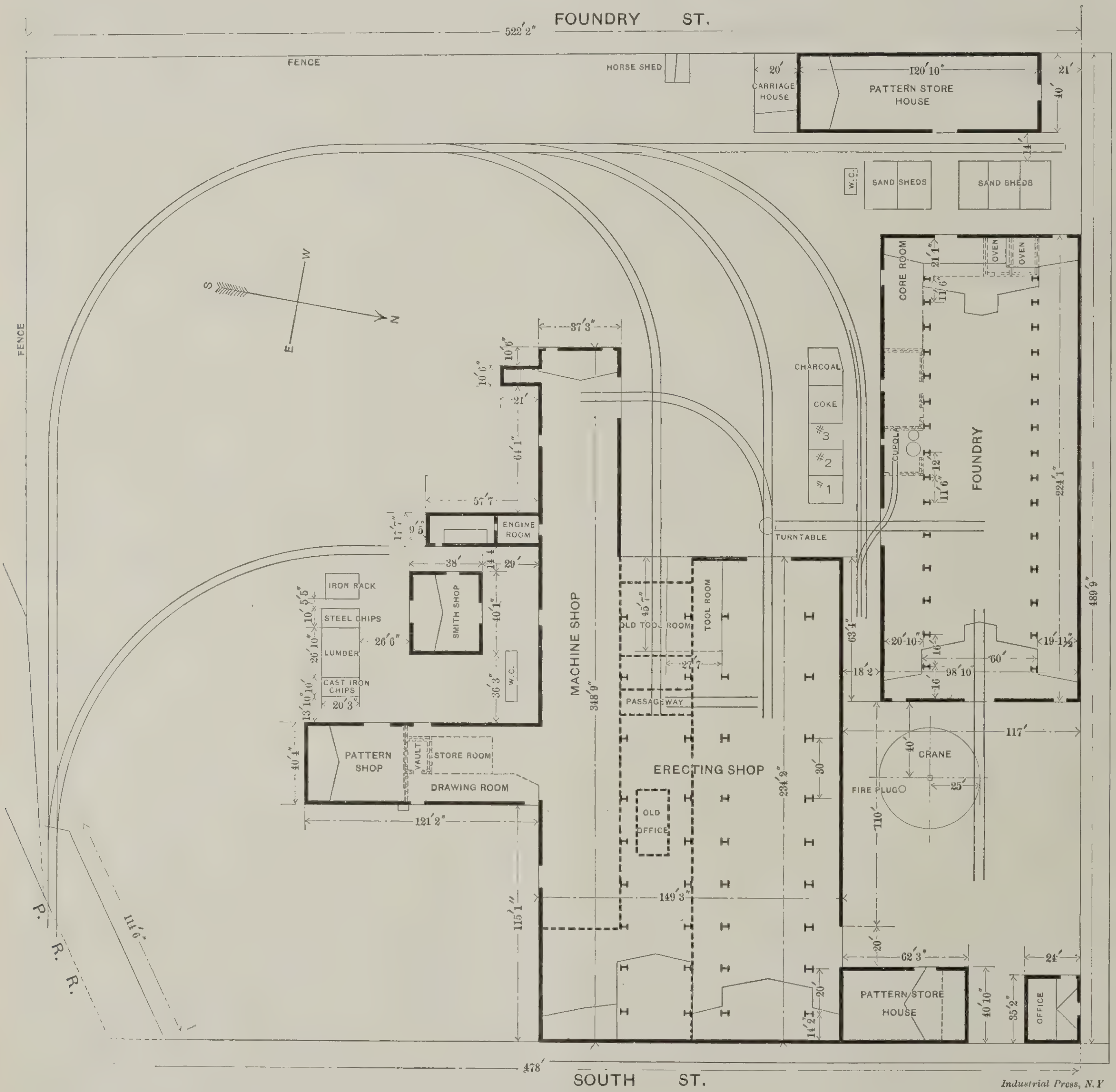
While such a system is practically a necessity in a modern telephone building, especially in cities where soft coal is burned, it is equally applicable to all public buildings, particularly in large cities where the air is laden with impurities and where the summer heat is almost unbearable. The time is probably not far distant when the marked advantages of such a system will be fully recognized and people will insist that they should be kept cool in summer as well as warm in winter.

* * *

A radial brick chimney was recently built in Newark, N. J., to accommodate an extension to the street railway power house. It is 250 feet high, 9½ feet inside diameter at the top and 13¾ feet inside diameter at the base of the circular column. The base is built of common brick, but the circular column is entirely composed of radial brick containing dead air spaces. The height of the base is 39 feet, and its width across "flats" is 21 feet. The base contains 160,000 common brick and the circular column 150,000 radial brick. The cost was $15,000.

THE RECONSTRUCTED SHOP OF THE BETTS MACHINE CO.

Machine shops built in these days and in accordance with modern ideas usually provide for expansion in some manner more or less consistent with the original plan of layout. This provision for future growth is very well illustrated, for instance, in the great plant of the Allis-Chalmers Co., at West Allis, Wis. Regarding the layout of this plant Mr. Edwin Reynolds is reported to have remarked, in a spirit of humorous exaggeration, that the wings of the main building could be extended indefinitely east and west, if need be, until they meet on the opposite side of the globe, and with that point reached, sufficient offset had been provided in the plan so that the extensions could pass by one another without interference and each make a complete circuit! But in the shop construction of the days gone by the probability of future growth usually appeared so remote or improbable that rarely was there any provision made for it. The result is that many a shop owner or manager has spent some bad days and nights trying to devise plans for extending his plant without tearing them down and building anew. And it has somtimes proved that an old plant can be remodeled into an up-to-date shop without tearing down the old shop or seriously disturbing the regular routine of work. An excellent illustration of an old machine shop converted into a modern plant with traveling cranes and other appurtenances for the economical production of heavy machine tools, is that of the Betts Machine Co. at Wilmington, Del., which forms the subject of the following description. The product of this well-known concern which was started by E. and A. Betts in 1860, is horizontal boring and drilling machines, planing machines, boring and turning mills and slotting machines.



Industrial Press, N.Y.

Fig. 1. Plan of Bett's Machine Co.'s Works, showing excellent Switching Facilities, etc. Note Outline of the Old Machine Shop partly indicated by Dotted Lines.

The layout of the plant is given in Fig. 1. The plot of land on which the buildings stand, extends about 490 feet on Maryland Avenue, and is bounded on the sides by South and Foundry streets. On the back is the Philadelphia, Baltimore & Washington Railroad, part of the Pennsylvania Railroad system, which gives unexcelled shipping facilities by rail. The plan of the old machine shop is included in that of the present machine shop, an end and a part of a side wall being indicated by heavy dotted lines. The locations of the old office, tool-room, etc., are also indicated in the same manner. A new office has been built on the corner of the plot at the junction of Maryland Avenue and South Street. The first addition to the shop was made some four or five years ago. It consists of a monitor roof erecting shop and heavy machine shop, 234 feet long and 75 feet wide, which was built parallel to the machine shop and at a distance from it of about 38 feet. It extended through to the street so that all the available space in that direction was taken up, the street line forming, as it were, the point of departure. A covered passageway connected the new erecting shop with the old machine shop. This section is equipped with two Shaw traveling cranes, one 10 tons and the other 20 tons capacity. The span of the cranes is confined to the width of the monitor; the aisles at the sides being reserved for tools. There are no galleries, all the floor space being on the ground. The machinery in this part of the plant is driven by electric motors belted to line shafts. Electric current for driving the motors is supplied by the city power station. The heavy planers and other heavy machine tools are located in this part. Across the northeast end is a 10-foot planer embodying a new feature of design of which we shall probably hear more later. It has a platen 38 feet long and but 6 feet wide. The platen is made in two parts which may be uncoupled in the center, and a one-half section used on short work. The side heads are mounted on supplementary, horizontal slides mounted on side rails of the housings. These slides solidly support the side heads when they are extended clear in to the sides of the platen. In this manner the capacity of a large planer is obtained with a comparatively light platen, which feature enables it to be advantageously used on work of a size and weight far less than its normal capacity.

Soon after the building of the erecting and heavy machine shop the increasing demand for heavy machine tools made it imperatively necessary to have more room, as the space between the old machine shop and the erecting shop, was roofed over, and the brick walls between them torn down. This gave one floor nearly 150 feet wide and 234 feet long in the main part. The old machine shop was extended to South Street, making it nearly 349 feet long. Its width is about 37 feet. The building of the new part and the tearing down of the walls supporting the roof of the old machine shop proceeded without stopping the machinery. When it is considered that the portion of the roof to be supported was nearly 300 feet long and that it carried a heavy lineshaft in motion, some difficulty of the work will be appreciated.

The roof of the new erecting shop was built considerably higher than that of the first one so as to give more head room under the crane. This was required by the increasing sizes of machine tools built by the company. The head room under the hook is about 27 feet. It is a Pawling & Harnischfeger, capacity 20 tons. The lighting in this section is superb. A large proportion of the side area above the adjacent sections is given up to glass, as will be seen in the illustrations, Figs. 2 and 3. Reference to the plan, Fig. 1, will show that the new erecting shop, in effect, acts as a large monitor or clearstory for the adjacent sections, the old machine shop forming one side. The floor in both of the new sections is of heavy plank laid on beams which are bedded in steam ashes. The floor in the machine shop is of brick, being the original floor and still in fair condition. Railroad switches run directly into both sections of the erecting shop, and a switch is laid along the side of the foundry. Crossing these tracks are shop tracks of standard railway gage for short cars on which heavy castings may be delivered from the foundry to the machine shop or erecting shop, by different routes, using either the railway tracks or the shop tracks. Another switch delivers coal directly into the boiler rooms supplying the shop engine.

The superintendent's office is in the drafting room, and just back of the drawing room is the pattern shop. This arrangement brings the two departments in close touch. The location of the superintendent's office is convenient to all

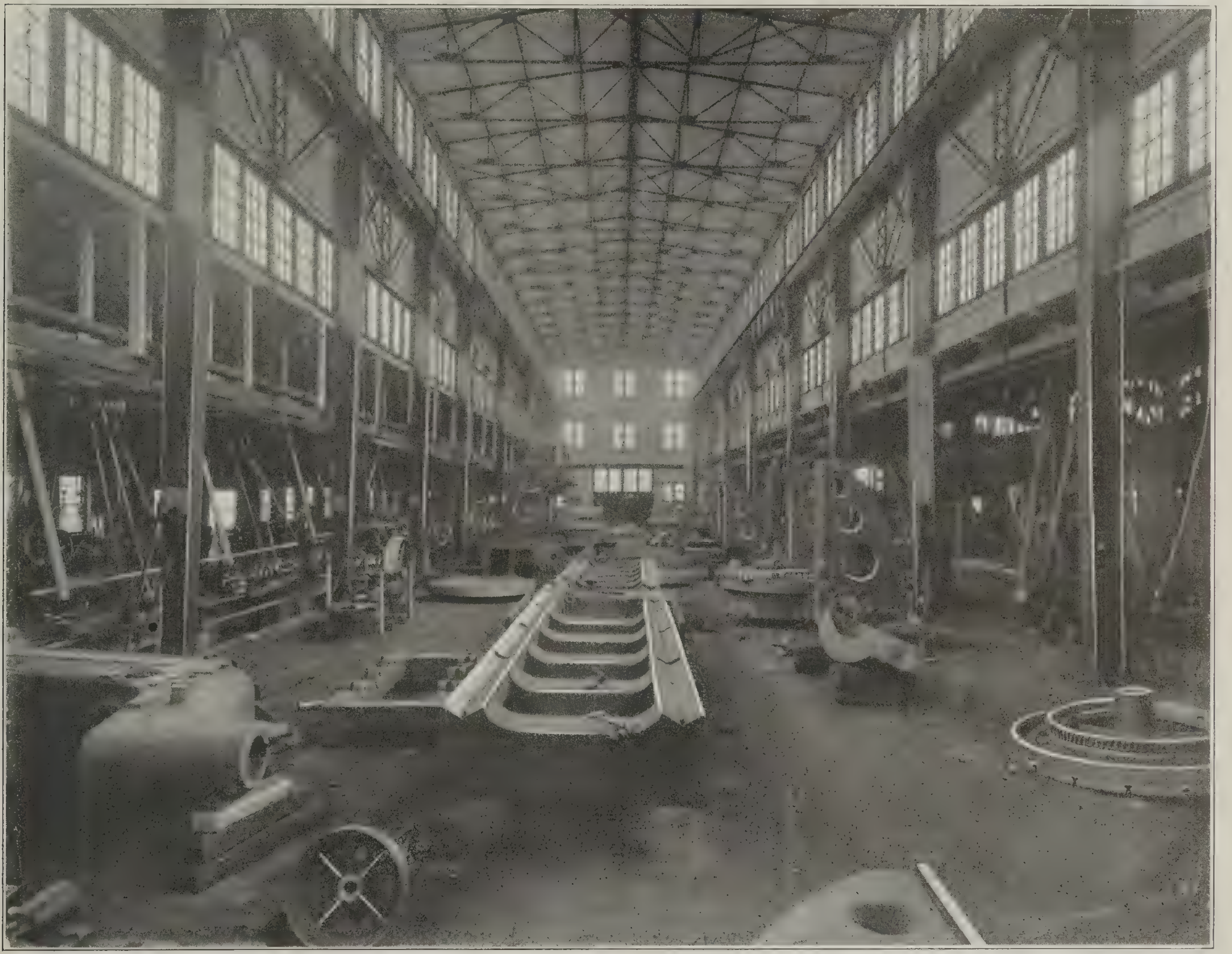


Fig. 2. View of New Section of Erecting Shop, looking nearly West. Boring Mill at the left in background is under Working Test and is Roughing the Faceplate of another Mill. Old Machine Shop Section at the left.

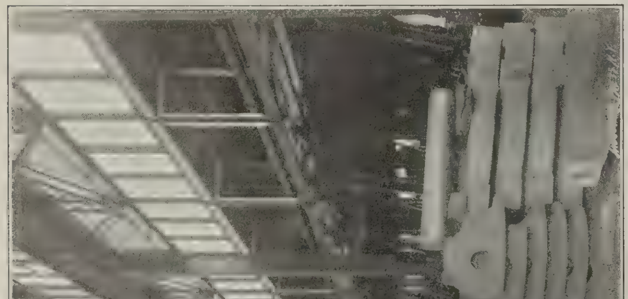


Fig. 3. New section of the Erecting Shop, looking nearly East.

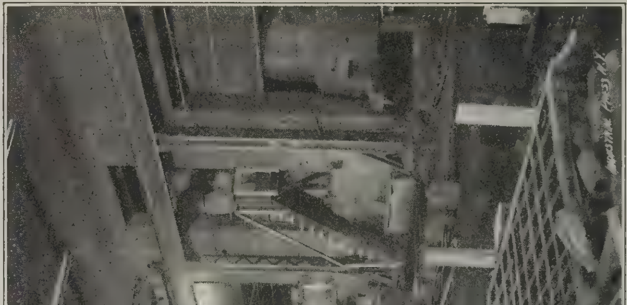


Fig. 4. View of Foundry showing the newer part. Two Traveling Cranes.

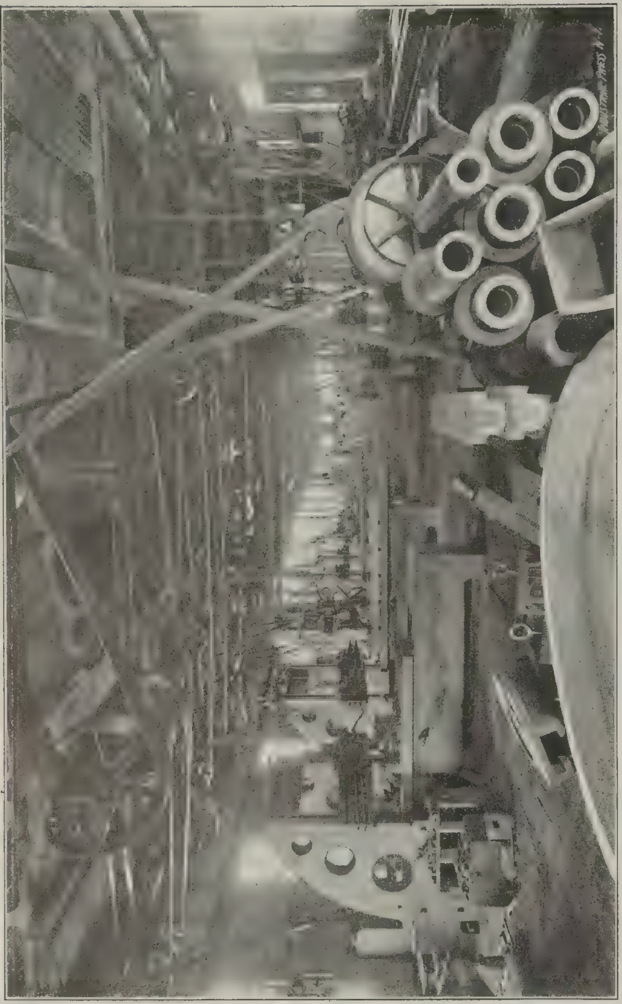


Fig. 5. View in Old Machine Shop Section, looking nearly East. Small Planer Department in Foreground.

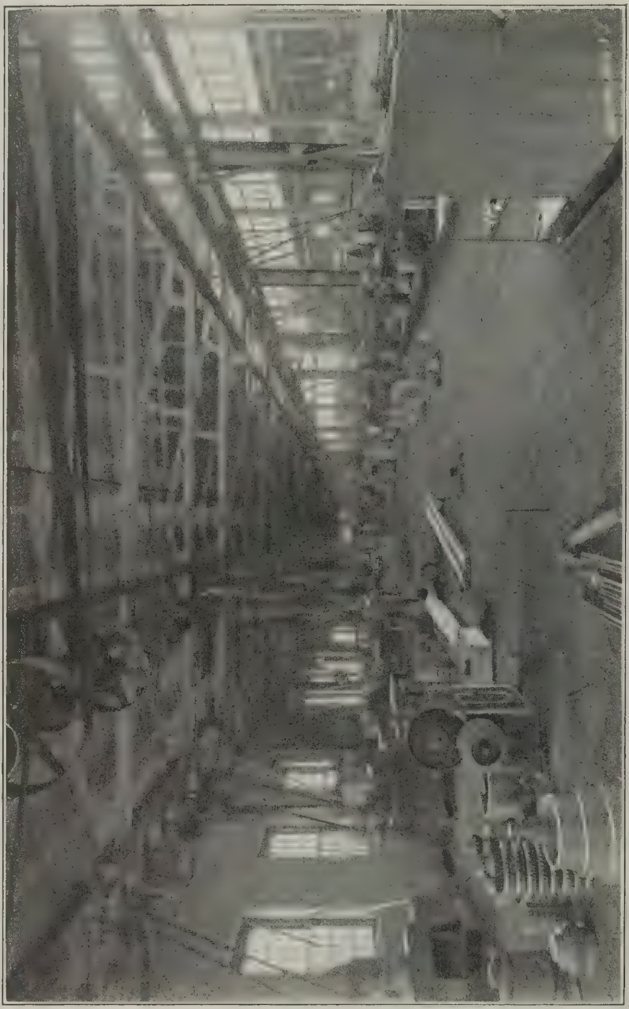


Fig 6. View of Old Machine Shop from opposite end. The Screw Machines are at this end.

parts of the machine and erecting shops, but is somewhat removed from the foundry. The small blacksmith shop is also close at hand.

In the illustrations, Figs. 5 and 6, which are views of the old machine shop taken from opposite ends, it will be observed that the roof trusses are of a peculiar construction seldom or never seen now. They are made of cast iron, and the same principle of construction, but of much longer span, was employed for the roof trusses of the old part of the foundry. The old part is about one-half the length of the present structure. In the new part of the foundry steel trusses, of course, were used. The length of this building is 224 feet and its width is 98 feet. It is well equipped with large cupolas, traveling cranes and the other accessories of a modern foundry. Besides making all their own castings considerable work is done for other parties.

A large storehouse for patterns stands back of the foundry, and another pattern storehouse is located at the opposite side of the plot near the office. As previously remarked, a railroad switch is laid alongside the foundry so that coal, coke, sand and iron may be brought directly to the door or unloaded into the adjacent storage sheds.

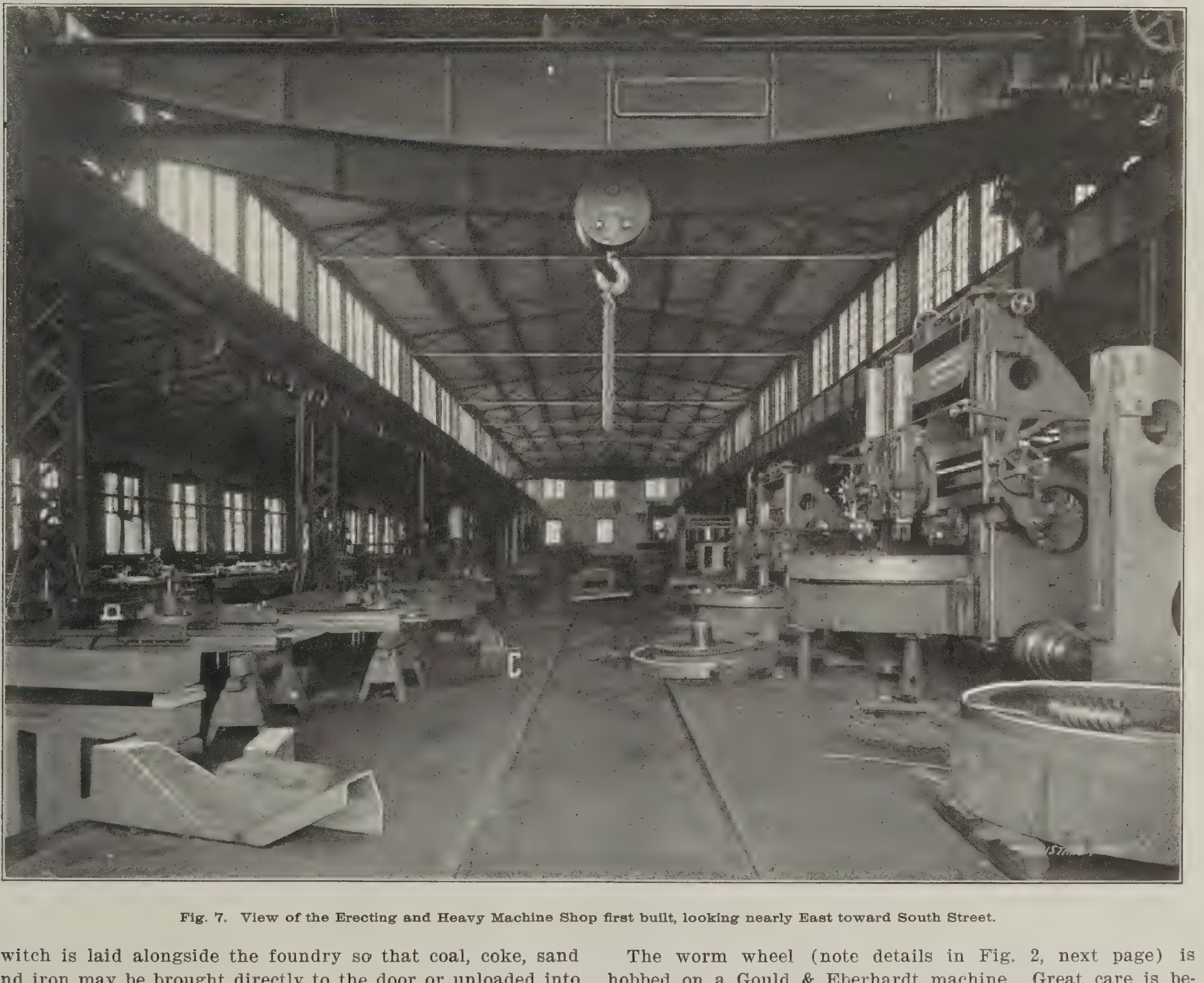


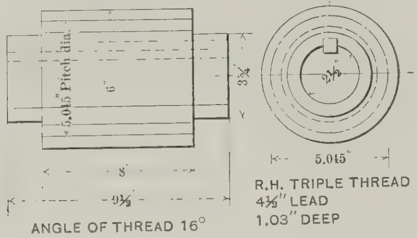
Fig. 7. View of the Erecting and Heavy Machine Shop first built, looking nearly East toward South Street.

THE BETTS WORM-DRIVEN BORING MILL.

An interesting feature of the product of the Betts Machine Co. is the design of their worm-driven boring mill, which they have been manufacturing for the past few years. In this machine—made in 5-foot, 6-foot and 7-foot sizes—the cone pulley is mounted on a shaft carrying a triple-thread, bronze worm engaged with the teeth of a cast-iron worm wheel, which is bolted directly to the under side of the revolving table or faceplate. The worm-gear driving mechanism makes a simple and powerful combination, since a large velocity ratio may be effected with only two members, and efficiently, too, it appears, when the proportions of diameter and pitch are correctly designed. In the 5-foot mill the worm wheel has 72 teeth of 1½ inch pitch, and since the worm engaging it has a triple thread of 4½ inches lead (1½ inch pitch), it follows that the velocity ratio is 24 to 1, that is, the cone pulley must make twenty-four turns to one revolution of the faceplate.

In the first design of the boring mill a worm wheel and worm of the hour-glass or Hindley type was used, but with indifferent success. What advantage this type of worm gear is supposed to possess in the matter of tooth contact was more than offset by lack of accuracy in the tooth spacing of the worm wheel. That is, it appeared to be impossible to get this type of gear made with the accuracy demanded by modern boring mill practice. In the boring of a small hole, when it is necessary to run the table at high speed, and which is the supreme test of accurately cut gearing, every tooth in the worm wheel insisted on being in evidence in the bored hole, it being possible to tell the number of teeth by simply counting the chatter marks. So the Hindley type of worm and worm wheel was discarded in favor of a plain worm and a simple hob-cut worm wheel.

The worm wheel (note details in Fig. 2, next page) is hobbed on a Gould & Eberhardt machine. Great care is bestowed on the cutting of the worm wheel and in chasing the worm, but after all possible care has been taken it is necessary to carefully grind the two together under exactly the same conditions they will be in in use. This is done, of course, by assembling them and grinding in the boring mill for which they are designed. A tooth space of the worm wheel is first marked; also a spot on a thread of the worm. The two are then engaged so that these marks coincide, and the grinding begins. White sea sand mixed with water is the abrasive used, it having been found superior to other combinations. It has also been found that when grinding has once been started, there must be no let-up in pressure, but that the worm must be forced against the teeth with considerable pressure, and followed up as the grinding proceeds. If the attempt is made to grind with the two running together freely, the invariable result is an inaccurate job which can be corrected only with difficulty. But by forcing the worm down during the grinding process the high spots are worn down uniformly, and the tendency seems to be to form all the teeth to same thickness and pitch. This applies, of course, only when the original limits of inaccuracy were narrow. Another effect of the grinding is that the mating members are, to a minute extent, made to imitate the shape of the Hindley worm and worm wheel. During the grinding process the boxes *E E′*, Fig. 3, are held loosely by their bolts. Simple wrought-iron fixtures with setscrews are clamped to the boring mill frame behind the boxes, and the screws are used to force the worm against the worm wheel.



Industrial Press, N.Y.

Fig. 1. Details of Worm for Five-foot Mill.

The end thrust of the worm is taken by a ball-bearing containing 14 balls ⅞ inch diameter, in the case of a 5-foot mill. Regarding the use of a ball bearing for duty like this there seems to be no trouble when the balls are proportioned for the work they have to do. Most of the trouble encountered when the ball bearing has been used for heavy work, is due either to its not being proportioned to the pressure, or to the speed having been too great. In this case the highest speed is about 600 revolutions per minute, which is the speed necessary to give the periphery of a 4-inch hole a velocity of 25 feet per minute. The worm and worm wheel run in a bath of oil, insuring perfect lubrication at the comparatively low speed at which the worm wheel operates. In the 5-foot mill the worm is 8 inches long, 6 inches outside diameter, 5.045 inches pitch diameter, depth of thread 1.03 inches. As already stated it is triple thread, 1½ inch pitch and 4½ inches lead. The angle of thread, with a line perpendicular to its axis, at the pitch diameter is 16 degrees. Fig. 4 shows the faceplate removed and the worm and ball bearing exposed to view.

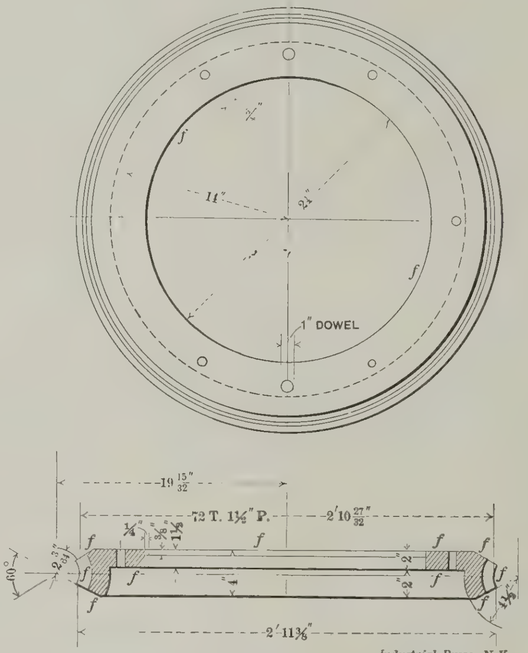


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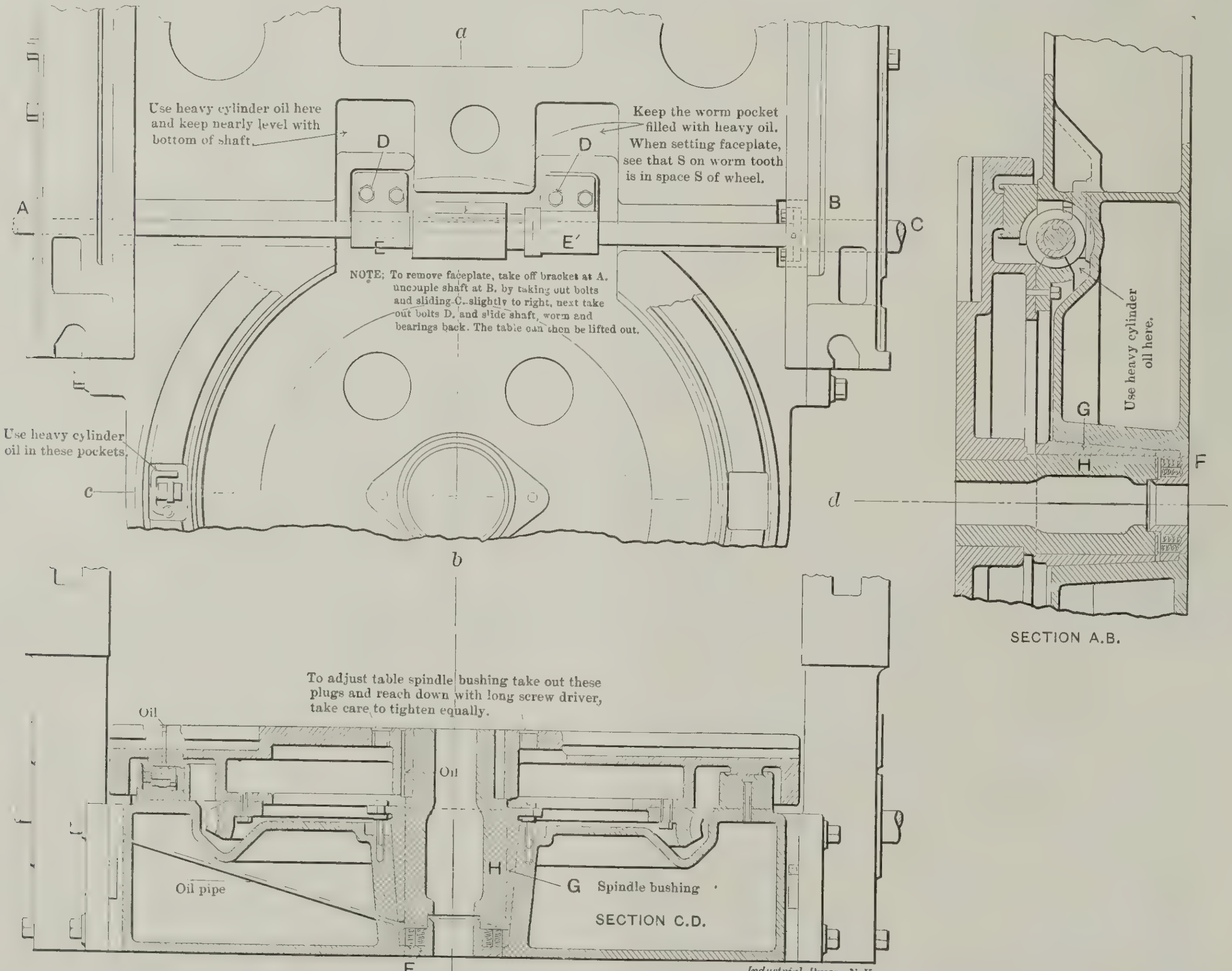
Fig. 2. Details of Worm-wheel for Five-foot Mill.



Use heavy cylinder oil here and keep nearly level with bottom of shaft.

Keep the worm pocket filled with heavy oil. When setting faceplate, see that S on worm tooth is in space S of wheel.

NOTE; To remove faceplate, take off bracket at A. uncouple shaft at B. by taking out bolts and sliding C. slightly to right, next take out bolts D. and slide shaft, worm and bearings back. The table can then be lifted out.

Use heavy cylinder oil in these pockets.

Use heavy cylinder oil here.

To adjust table spindle bushing take out these plugs and reach down with long screw driver, take care to tighten equally.

Spindle bushing

Industrial Press, N.Y.

Fig. 3. Instruction Sheet sent out with Worm-driven Boring Mill, showing Construction and giving Directions as to Care, etc.

Another interesting feature of this design of boring mill is the step bearing, and the manner of relieving the load on the outside ring bearing. The common practice in boring mill construction, as we all know, is to provide screw connection in the front of the base by which the operator can take part of the load off the ring bearing and place it on the pivot or step bearing, when running at high speeds. Like all features of adjustment in machine construction, this one is likely to be abused. If the table is lifted too high, which is likely to be the case unless the operator is more than ordinarily careful, there will likely be a lack of concentricity between the turned periphery of, say, a pulley and the hole bored in the hub. In the Betts mill no adjustment is provided for the operator to manipulate. The load on the outer bearing ring is relieved automatically and at all speeds. A circular cast-iron disk fits in the bottom of the spindle hole. This is drilled with a number of $\frac{7}{8}$-inch holes, say, 24. In these holes are placed a certain number of coiled springs, the number being determined by experiment on each mill. On top of the springs is a bronze plate upon which rests the spindle *H*, Fig. 3, of the table. When the mill is assembled, the disk *F* is partly filled with springs, say 22 are put in. The table is lowered with strips of thin paper placed on the outer bearing ring. If, when the table is down, the strips of paper are found loose, some of the springs are removed—say 2. This leaves 20, and then the table is replaced. If then the strips of paper are found to be pinched, it is fair to presume that the weight of the table is approximately balanced by the springs. The condition of approximate balance having been determined, the table is again removed and one-fourth of the number of springs taken out, leaving in this case 15 springs in place. In this way it is calculated that 75 per cent. of the weight of the table is balanced on the step bearing. Of course the weight of the work on the table reduces the proportion of the load borne by the step, but as it is usually only comparatively light work that is run at high speeds, this objection is not considered serious. The step bearing is also shown in Fig. 4, setting beside the spindle bushing.

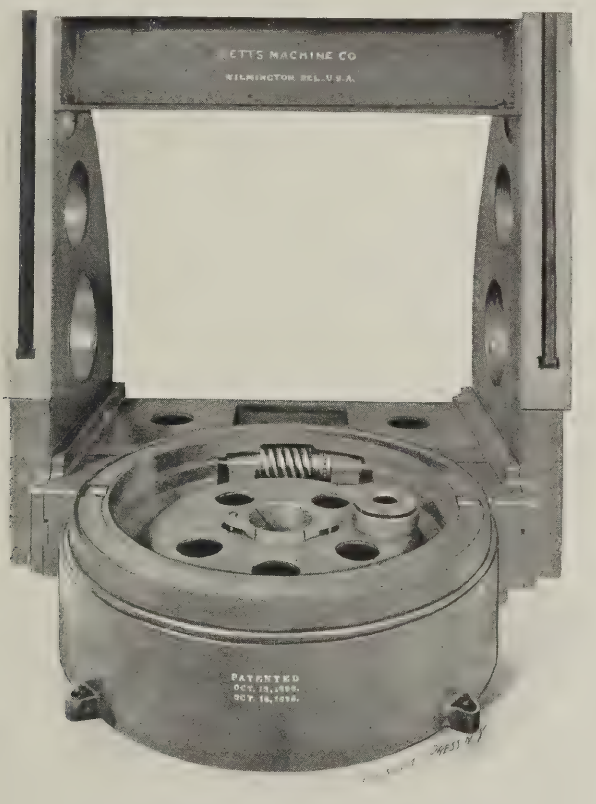


Fig. 4. View of Boring Mill with Faceplate removed, showing Worm, Ball Thrust Bearing and Step Bearing.

The cut, Fig. 3, used to show the principle of construction, was made from an instruction blueprint regularly sent out with all worm-driven boring mills. The plain directions for the care and adjustment of the mill are reproduced. While there is nothing new in sending out instruction sheets like these, in our opinion many machine tool builders could very profitably follow and extend the practice. Anything that will help a machine to be understood and cared for is to the mutual profit of all concerned.

THE DIFFERENTIATION OF ENGINEERING.

The best definition of civil engineering is probably that which was given seventy-five years ago by Thomas Tredgold, namely: "Civil engineering is the art of directing the great sources of power in nature for the use and convenience of man." At the time this was written, however, there were but two recognized branches of engineering, one designated as civil engineering, and the other as military engineering, the former including all those branches not directly connected with military operations. But the remarkable series of mechanical inventions which distinguished the last third of the eighteenth century—the spinning jenny by Hargreaves, the spinning frame by Arkwright, the mule by Crompton, the power loom by Cartwright, the steam engine by Watt, the puddling process by Cort, and others—followed in the first third of the past century by the development of the steam locomotive by Stephenson, the steamboat by Fulton, and by further great improvements in the manufacture of iron and steel, soon led to the differentiation of civil engineering into several branches. The first branch to leave the parent stem was mechanical engineering, followed by metallurgical and mining engineering as the developments in the mining and reduction of metals progressed; and toward the middle and end of the last century the tremendous advance in all branches of applied science speedily differentiated engineers into the classes named, as well as into others. For instance, within the last quarter of a century the development of the electric motor and other great discoveries in electrical science have led to the development of electrical engineering as a distinct profession, while the advances in sanitary science and the discoveries with reference to the nature, causes and prevention of disease have resulted in the development of sanitary engineering as a branch of civil engineering quite extensive enough to constitute a profession by itself. But notwithstanding the divergence of all these branches from the parent stem of civil engineering, even what is left to be included under this title remains undoubtedly the widest in scope of all the engineering professions, and in practising it a man must become a specialist in some one branch. It comprises the construction of railroads, of roads, of canals, of street and interurban railways, the improvement of rivers and harbors, the construction of lighthouses and other works necessary for carrying on trade and commerce; it includes structural engineering, or the construction of bridges, aqueducts, foundations, steel frames for buildings, etc.; it treats of hydraulic engineering, including the development of water powers, and the construction of dams and power plants up to the point at which the mechanical engineer is called upon to supply the motors; it deals with surveying, which is necessary in the laying out of works of all kinds, but constitutes also a branch by itself known as land surveying, which, when extended to the survey of very large areas in which the curvature of the earth must be taken into account, leads to the intricate problems of geodesy, or the measurement of the earth, and touches upon the field of terrestrial physics; and it further includes a great variety of problems due to the congregating of persons in cities—undoubtedly the most striking sociological development of the last century—including works of water supply, sewerage, the drainage of buildings and lands, the disposal of wastes, and the construction and maintenance of streets and pavements. This last group of problems, involving the health of communities, although now the special field of the sanitary engineer, is more generally considered as a branch of civil engineering. Broadly speaking, it may be said that civil engineering deals with structures, or works at rest; while mechanical engineering deals with machines and motors, or works which are in motion. It will be seen, however, that the execution of civil engineering works requires at many points the collaboration of the mechanical or the electrical engineer, and that it also brings the practitioner into close contact with economic and sociological problems.—*Prof. Geo. F. Swain in the N. Y. Tribune.*

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Machine shop profits to-day are made up out of time that used to be wasted by the old methods.

ACCURATE MACHINE DESCRIPTION.

A NOVEL METHOD OF MAKING NOTES OF MACHINE DIMENSIONS.

CHARLES H. FITCH.

In order to solve a problem we must know its elements. If the solution is graphical, these elements are measures of lines or dimensions. If it be arithmetical the elements are numbers. If analytical or algebraical the elements are quantities designated by letters to which numeral values may be assigned, or which may have definite relations to each other whether values are assigned to them or not. It is usually more convenient to solve problems graphically than analytically, but the analytical solution may be more exact, and the study of the problem by analysis sometimes leads to the discovery of new and useful relations. A well qualified mechanical engineer and mathematician is able to use analytical methods, although where equations become involved and complicated most practical men would beg off from the time, mental labor and difficulty involved by this treatment.

I hold, however, that all methods have their uses, and that there is in particular a useful unoccupied field for such accurate text descriptions as will enable a draftsman to sit down with them and develop therefrom all the drawings necessary to make patterns and do the machine work—in fact, to build the machine from the text.

As it is now, we all know that machine descriptions are very loose and incomplete. The text gives us an idea of the general nature of the machine by appealing to our familiarity with similar constructions and mechanical elements. This is usually assisted by a picture of the machine in perspective, and perhaps by sectional drawings on too small a scale for accurate reproduction by taking off measurements with dividers.

This may suffice very well for general public information in cases where it is not desired to tell too much or to make it too easy to copy the machine. To do this the machine must be re-designed. The description and cuts are, in fact, a language designed "to conceal thought," although it would be more accurate in this case to say that the language was partly to conceal and partly to reveal the thought embodied in the machine.

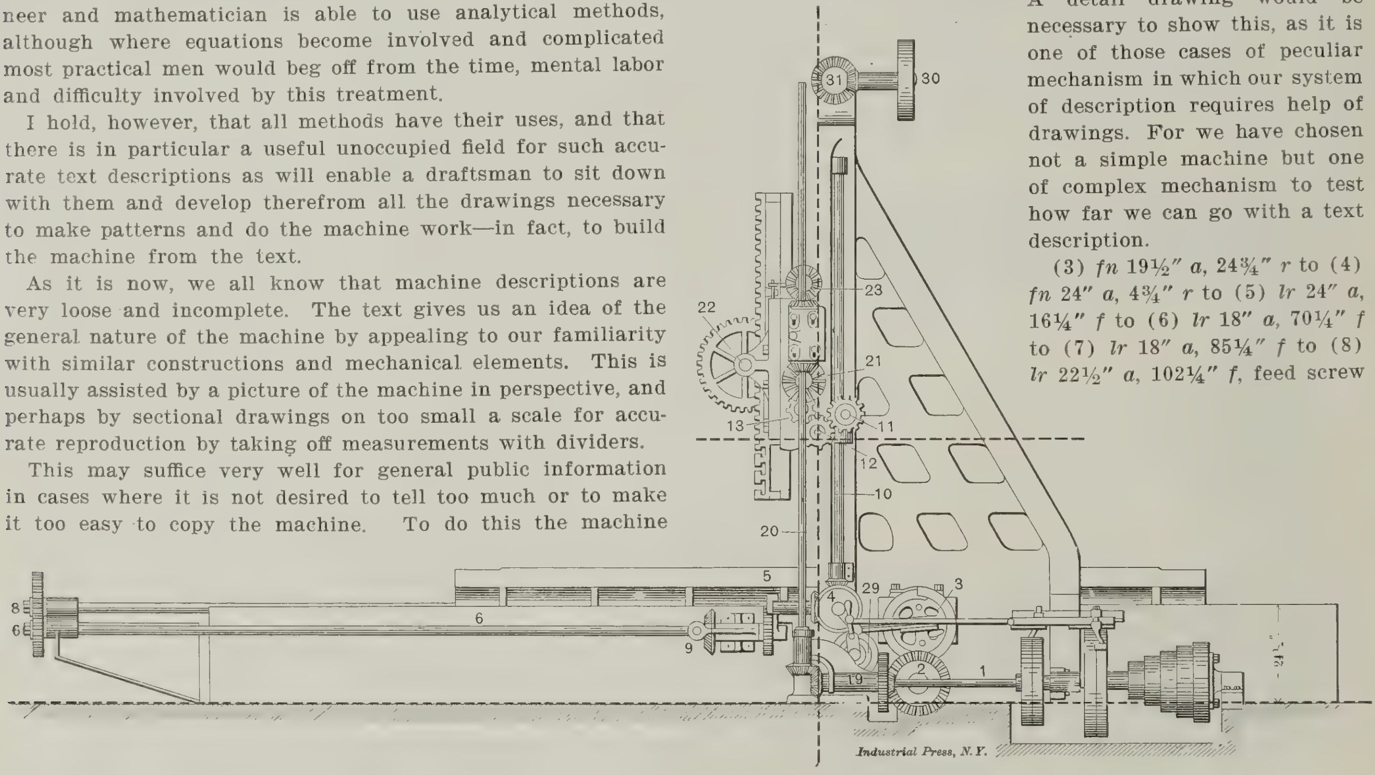


Fig. 1.

We have to offer in this article a kind of description which will suffice for the location of all the center lines and axes of motion and working surfaces of a machine, and take for illustration the slotting and drilling machine shown in cuts Fig. 1 and Fig. 2.

The scheme of description is as follows:

All points, lines and regular definable surfaces in space can be referred to three planes and will then be completely determined. In some cases it may be convenient to choose parallel planes for convenience of reference, but practically we have three planes in any case. The planes chosen have traces or projections shown by broken lines on Figs. 1 and 2. Directions with reference to the several planes are indicated by letters.

From the horizontal plane, *ab* = above, below.
From the face vertical plane, *fn* = far, near.
From the cross vertical plane, *lr* = left, right.
These planes are as assumed in Fig. 1.

Now if we start our description with the driving shaft of the platen power feed, its direction is *lr*, left to right. Its center is 5″ *a*, that is 5″ *above* horizontal plane; and 4¾″ *f*, that is, 4¾″ *far* or beyond (not near, or this side of) the face vertical plane. The location is not shown in Fig. 2, being behind plate of frame, the axis being No. (1) gearing with No. (19).

Designating axes of motion by numbers in parenthesis, the above description may be condensed and proceeded with as follows:

Platen power feed. (1) *lr* 5″ *a*, 4¾″ *f*, driving shaft to (2) *fn* (far near direction) 5″ *a*, 24″ *r* (24″ to the right) to (3) *fn* 19½″ *a*, 24¾″ *r*.

Note on (2-3); feed escapement. The intermittent feeds are given by a peculiar escapement movement which, in conjunction with ratchet wheels in the dependent trains, regulates the feeds. A friction pinion grooved about its girth meshes with a friction wheel having a segmental half-around grooved rim, either end of the grooves having a partial extension in a toothed pawl hung within the wheel, so that while connection is broken after a half turn either way, and the feed motion is positively stopped by lugs, upon reversal of motion of the pinion the wheel re-engages by means of one of the pawls. A detail drawing would be necessary to show this, as it is one of those cases of peculiar mechanism in which our system of description requires help of drawings. For we have chosen not a simple machine but one of complex mechanism to test how far we can go with a text description.

(3) *fn* 19½″ *a*, 24¾″ *r* to (4) *fn* 24″ *a*, 4¾″ *r* to (5) *lr* 24″ *a*, 16¼″ *f* to (6) *lr* 18″ *a*, 70¼″ *f* to (7) *lr* 18″ *a*, 85¼″ *f* to (8) *lr* 22½″ *a*, 102¼″ *f*, feed screw for platen nut. (6) may also be driven from (9) *fn* 18″ *a*, 31″ *l*, constituting the platen hand feed.

Slotter-frame Power Feed.—(4) *fn* 24″ *a*, 4¾″ *r* to (10) *ab* 16¼″ *f*, 4¾″ *r*.

Branching of Power Feeds.—(4—5 and 4—10). The stud on *n* (near) face of *n* (near) side post carries a bevel gear rocked by connecting rod and arm, and this gear at once meshes with two bevel pinions one on *ab* (above-below or up and down or vertical), and one on *lr* (left-right) shaft, making it the branching piece for slotter frame and platen feeds, respectively.

Slotter-frame Power Feed Continued.—(10) *ab* 16¼″ *f*, 4¾″ *r* to (11) *fn* 7″ *a*, 4½″ *r* to (12) *fn* 2½″ *a* 2, 1½″ *l* to (13) *fn* 8¾″ *a* 2, 4 3-16″ *l*, feed screw for slotter-frame nut. The *a*2 merely indicates that we have transferred our horizontal reference plane to an upper movable plane.

Slotter-frame Hand-feed.—(14) *lr* 26″ *a*, 192¾″ *f* to (15) *ab* 2¾″ *r*, 192¾″ *f* to (16) *fn* 2¾″ *r*, 8¾″ *a*2, to (13) *fn* 4 3-16″ *l*, 8¾″ *a*2.

Drill Frame Hand Traverse.—(17) *lr* 6 7-16″ *a*2, 9½″ *n*2 to (18) *lr* 11 7-16″ *a*2, 9½″ *n*2, axle of traverse wheel meshing with thread of screw (13). The use of *n*2 obviously indicates transition to another *fn* (far near) vertical reference plane, parallel with the first, and movable.

Slotter Tool Train.—(1) *lr* 5″ *a*, 4¾″ *f* to (19) *lr* 5″ *a*, 6″ *n*, to (20) *ab* 4½″ *l*, 6″ *n* to (21) *fn* 4½″ *l*, 14¼″ *a*2, *to* (22) *fn* 18″ 55 *l*, 19½″ *a*2.

Drill Tool Train.—(20) *ab* 4½″ *l*, 6″ *n* to (23) *fn* 4½″ *l*, 40⅜″ *a*2, to (24) *ab* 4½″ *l*, 11″ *f*2 to (25) *ab* 11¼″ *l*, 0″ *f*2. Note on tool train engagements (20 to 21) and (20 to 23): A single train of mechanism serves to operate either drill or slotting tool with the following disengaging device. The upper part of *ab* (or vertical) power shaft for the tool motions is carried by a bearing bolted upon *n* (near) end of cross-slide with bolt holes elongated *ab* (or vertically) so that the bearing may be slipped and set up or down, carrying with it a bushing having a bevel pinion below and a miter above the bearing, either one of which may be thus disengaged, while the other is thrown into gear with its train.

The Slotting Bar (22 and following). The rack of slotting bar has a 6″ face *fn*, and extends *l*-ward (or to the left) from a 12″ *fn* by 2½″ *lr* slide bar retained on either side by gibs, while take-up for wear is provided by three long *ab* keys two on *l* side, either side of rack and one on *n* side of bar, which keys are set by means of stud bolts in the slotter frame, with jamb nuts.

Drill Feed Train.—(23) *fn*, 4½″ *l*, 40⅜″ *a*2 to (26) *fn* 8¾″ *l*, 47⅞″ *a*2 to (27) *fn* 14 15-16″ *l*, 33″ *a*2, to (28) *ab* 19 1-16″ *l*, 13″ *f* to (25) *ab* 11¼″ *l* to 0″ *f*2. Drill feed train (23 to 26) spurs are geared 50 to 58 teeth, (26 to 27) cone pulley of 4 steps 12″ diameter to 4″ diameter, faces 1⅝″, belting to cone pulley 6½″ diameter to 14½″ diameter. (27 to 28), worm gearing with worm wheel (28 to 25), spurs geared in ratio 3 to 5, the latter keyed on nut of feed screw extension of drill spindle. The screw is right hand, square thread, ½″ pitch, 47¼″ long, and with thrust bearings above and below. Where it joins drill spindle there is keyed upon it a cross-bar whose *fn* wings guide in slots of *ab* pillars of the drill frame.

Belt Shifting Train.—(1) *lr*, 5″ *a*, 4¾″ *f* to (29) *fn* 12″ *a*, 9¼″ *r*.

Cross Slide (ab) Traverse.—(30) *lr* 158 *a*, 12″ *f* to (31) *fn* 158″ *a*, 6″ *r* to (32) *ab* 27½″ *f*, 6″ *r* and (33) *ab* 174½″ *f*, 6″ *r*.

This sufficiently illustrates the plan of a universal system of description of machinery trains and elements.

The first suggestion is that it may add new terrors to technical reading. That may be so, but if we take up a magazine devoted to textile design or ladies' embroidery we will encounter long descriptions for making patterns and stitch work designs which are essential to communicate the necessary information and which are very useful although they may have to be read needle in hand, and be no more suited to thrill the soul than are the genealogical records in the books of Moses.

This plan is, I think, worth putting on record in the technical engineering press, because it has utility. The foregoing description looks a little complex, but it is of a complex machine with many trains, the full details of which would require a large drawer full of drawings. I have found it useful in simpler cases in several ways.

First, as a time and labor saver. I can borrow a set of drawings and in a very short time can take off all the details necessary for their entire reproduction.

Second, as an inconspicuous record. These notes take hardly any space, and are a sort of shorthand which the casual reader cannot make out. They are private to that extent.

Third, as a check. A draftsman can use these dimensions to check his drawings.

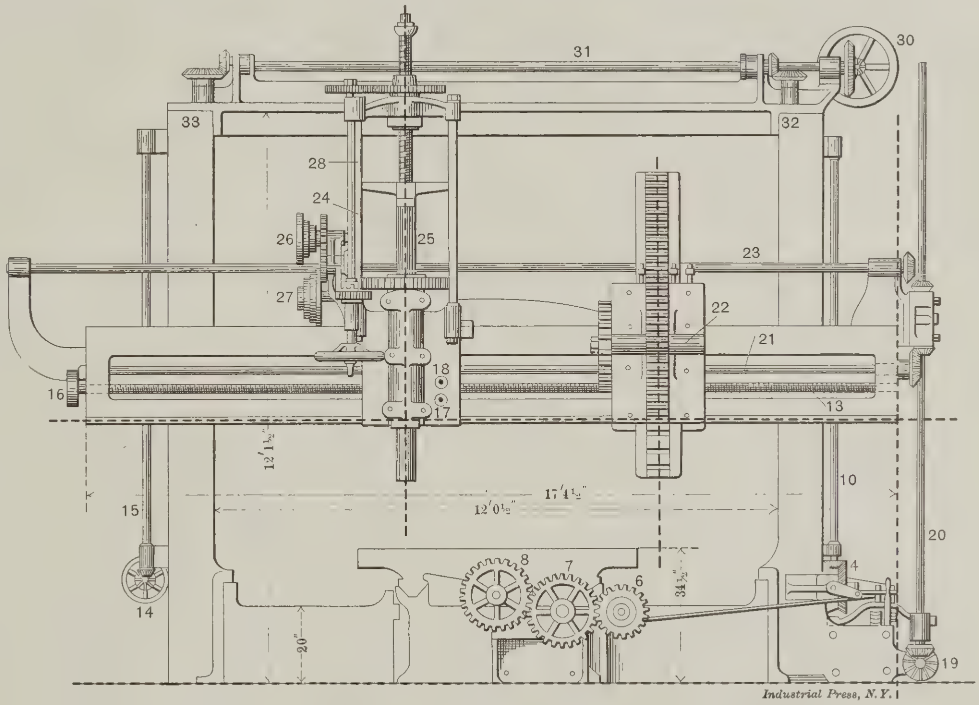
Fourth, for clearness of ideas. No one can analyze a machine in this way without knowing it better, and remembering clearly points that would otherwise be left in doubt or obscure.

There is still another useful purpose to which this method can be put. In comparing designs and designing in series, it helps to determine what is best, what parts can be worked to interchange, or used on several sizes or modified designs of a machine.

THE REVOLUTION EFFECTED BY FARM MACHINERY.

Farm machinery may some time do work for us that will be worth $1,000,000,000 a year. Theoretically it is already saving us nearly three-fourths that sum; for as far back as 1899, if all the crops to which machinery is adapted could have been planted and gathered by hand, they would have cost nearly $700,000,000 more than if they had all been planted and gathered by machinery. It has not only added so much to our wealth, but it has made us the foremost exporting nation, and it is changing the character of the farmer by freeing him from monotonous hand-toil. More than that, it is fast changing the immemorial conception of agricultural and the pastoral and idyllic associations that have gathered about it since the time of Abraham. Wealth, industry, commerce, the character of men and even their sentiment are all affected by it.

Yet so sudden have been these changes that we have yet hardly caught their meaning. The cradle-scythe is only a little more than a century old, and the cast-iron plow was first used even later than the cradle-scythe. In other words, a century ago agricultural machinery was almost as primitive as it was a thousand years ago. Now we have steam plows, combined harvesters and threshers and auto-mowers. They have come into use so recently that only a small part of the population have ever seen them at work. Yet they are changing our life in all its wide reaches—from commerce to poetry.—*World's Work.*



Industrial Press, N. Y.

Fig. 2.

* * *

A dozen miles up the Tyne Valley is the village of Wylam, where George Stephenson was born, in 1781. The old home is still there—a very plain, peak-roofed, stone cottage, now tenanted by a peasant family. On the ends of the cottage there are no windows, and there are but five on the front. In the eighteenth century, in England, windows were a luxury, for the householder had to pay a tax on them. This window tax was the outgrowth of the hearth tax. In earlier days the collector came around to count the number of fireplaces, that the householder might be taxed on them, but the English spirit—"every man's house his castle"—was opposed to this invasion of the privacy of the home, and the window tax was substituted as a tax that might be assessed from outdoors. Just in front of the Stephenson cottage runs one of the railways made possible by the genius of the inventor.—*Four Track News.*

* * *

Prof. Forrest R. Jones, who has contributed to our columns occasionally, is to leave Worcester Polytechnic Institute to become Professor of Machine Design at Sibley College, Cornell University.

SPIRAL GEARS.

DEVELOPMENT OF THEORY AND RULES FOR THEIR CALCULATION.

C. E. COOLIDGE.

The fact that the design of a pair of spiral gears involves so many possibilities and probabilities before the "eternal fitness of things" results, has stimulated a great many interested in the development of a pair of spiral gears to evolve methods which would require a minimum amount of labor. Graphical methods are most easily followed and understood by many, but a rigid and expedient treatment can only be obtained by the use of true and convenient equations which express the kinematic and kinetic relations of known properties of the gears.

The introduction of the terms sine, cosine, and tangent into the equations should not be held in abject terror by those who have thus committed themselves through the columns of current periodicals. The trigonometrical terms sine, cosine, and tangent of an angle express the ratio of two particular sides of a triangle with reference to the particular angle used, and with the multitudinous number of available books which contain the values of the ratios, common everyday arithmetic is substituted for the science of trigonometry as such.

The fundamental kinematic features of screw gearing, and in fact of all gearing, are nothing but special cases of the skew gear which is the general case. In other words, the skew gear with its hyperboloidal pitch surface is the mother gear of all.

A brief presentation of that particular feature might aid some in plucking a "brand from the burning" and I take the liberty of indicating a proof by the analysis of a pair of skew gears as follows: In the two views in Fig. 1, let *A-A*, *B-B*, and *l-l* represent the axes and line of contact respectively of a pair of skew and screw gears in contact whose axes are parallel to the plane of the paper. Also let

V = component linear velocity of point P common to both gears and perpendicular to line of contact l-l,

V' = component linear velocity of point P in line of contact taken perpendicular to axis A-A,

V'' = component linear velocity of point P in line of contact taken perpendicular to axis B-B,

α = angle between lines $V'P$ and PV,

β = angle between lines $V''P$ and PV,

R = radius of gear whose axis is A-A,

R' = radius of gear whose axis is B-B,

$R\ P\ M$ = rev. per min. of gear whose axis is A-A,

$R'\ P'\ M'$ = rev. per min. of gear whose axis is B-B.

The angular velocities of the two rolling hyperboloids are directly proportional to their R. P. M's and since the angular velocity equals the linear velocity divided by the radius of the rotating body we have

$$\frac{R\,P\,M}{R'\,P'\,M'} = \frac{\dfrac{V'}{R}}{\dfrac{V''}{R'}} = \frac{V'}{V''} \times \frac{R'}{R}, \tag{1}$$

$$\frac{V'}{V''} = \frac{\dfrac{V}{V''}}{\dfrac{V}{V'}} = \frac{\cos\beta}{\cos\alpha} \tag{2}$$

$$\frac{R}{R'} = \frac{R'\,P'\,M'}{R\,P\,M} \times \frac{\cos\beta}{\cos\alpha} \tag{3}$$

From (3) it is evident that the radii of the two gears are inversely proportional to the rotations about their axes if in Fig. 1 the angles made by the line of contact with the axes are equal, which is often of advantage in laying out screw gears.

The special cases of the skew gear as found in the more common gears are as follows: When the throat of the hyperboloidal surfaces contracts to a point, a double nappe cone with intersecting axes or the pitch surfaces of bevel gears results, with a zero velocity at P. When the hyperboloids are infinitely long, cylinders with parallel axes or the pitch surfaces of spur gears and twisted gears result with angles α and β equal to zero and the line of contact l-l making zero and equal angles respectively with the axes. When comparatively narrow lengths of the hyperboloidal surfaces, which are close approximations to cylinders, are used and the teeth are twisted into regular helices, the line l-l becomes a tangent to the helices at the point P and screw gears known under the more general term of spiral gears result.

Worm gears come under this head as a species of screw gear.

The designing draftsman of a pair of spiral gears must furnish the following data for use in the shop:

1. Outside diameters of the gears.
2. Pitch and number of cutter used.
3. Number of teeth cut.

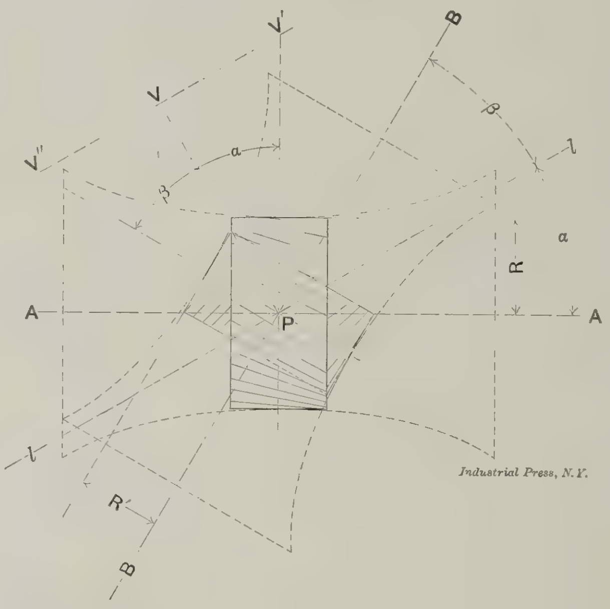


Fig. 1

4. Lead of spiral.
5. Angle of spiral with axis.

For working out the data for the shop the following formulæ with their derivation are adequate and convenient. Using the notation above and adding

d = sum of pitch radii of gears and shortest distance between axes,

N = number of teeth on gear whose axis is A-A,

N' = number of teeth on gear whose axis is B-B,

n = number of teeth on osculating circle of gear whose axis is A-A,

n' = number of teeth on osculating circle of gear whose axis is B-B,

D = diametral pitch,

a = lead of spiral of gear whose axis is A-A,

a' = lead of spiral of gear whose axis is B-B,

we have

$$\frac{N}{N'} = \frac{R'\,P'\,M'}{R\,P\,M} \tag{4}$$

$$\frac{R}{R'} = \frac{R'\,P'\,M'}{R\,P\,M} \times \frac{\cos\beta}{\cos\alpha}, \tag{5}$$

$$n = \frac{N}{\cos^3\alpha}, \tag{6}$$

$$n' = \frac{N'}{\cos^3\beta}, \tag{7}$$

$$a = 2\,\pi\,R \operatorname{tang}\,(90^\circ - \alpha), \tag{8}$$

$$a' = 2\,\pi\,R' \operatorname{tang}\,(90^\circ - \beta), \tag{9}$$

$$\frac{2\,d\,D}{N'} = \frac{1}{\cos\beta} + \frac{R'\,P'\,M'}{R\,P\,M} \times \frac{1}{\cos\alpha}. \tag{10}$$

(4) is self-evident, being the common property of all gearing, (5) has been derived for skew gears and answers for spiral gears which are a special case of skew gears as indicated above. In equation (6) the derivation is as follows: In Fig.

2 is shown one of the pair of gears shown in Fig. 1, whose axis is *A-A*. Using the notation above and adding

p = normal pitch,
c = circumferential pitch,
s = semi-major axis,
r = radius of osculating circle.

If a cutting plane be taken perpendicular to the plane of the paper and to the tangent line *l-l* at the point *P* an ellipse will be cut from the cylinders whose true configuration is shown revolved into the plane of the paper. The radius of the osculating circle (a circle touching the greatest number of points) to the ellipse at the end of the minor axis is derived most easily from Calculus and its value is equal to the square of the semi-major axis divided by the semi-minor axis or from Fig. 2,

$$r = \frac{s^2}{R}, \qquad (11)$$

also from Fig. 2, $s = \dfrac{R}{\cos a}$. (12)

Substituting s in (11), $r = \dfrac{R}{\cos^2 a}$. (13)

Multiplying the diameter of a circle by the diametral pitch gives the number of teeth on the circle or the number of teeth on the osculating circle just found,

$$n = 2\,r\,D = \frac{2\,R\,D}{\cos^2 a} \qquad (14)$$

$$\text{Since } D = \frac{\pi}{p}, \qquad (15)$$

and from Fig. 2, $p = c \cos a$. (16)

Substituting p in (15), $D = \dfrac{\pi}{c \cos a}$. (17)

Substituting D in (14), $n = \dfrac{\dfrac{2\,\pi\,R}{c}}{\cos^3 a}$. (18)

Since $\dfrac{2\,\pi\,R}{c}$ = number of teeth on gear, $n = \dfrac{N}{\cos^3 a}$.

Equation (7) is derived similarly to (6). Equation (8) is derived as follows: In Fig. 3 let one of the pair of spiral gears shown in Fig. 1 with axis *A-A* be sufficiently extended to complete one turn of the helix about the pitch cylinder. In the lower view of Fig. 3 the development of the cylinder and the helix on its surface readily shows that $a = 2\,\pi\,R \text{ tang } (90° - a)$.

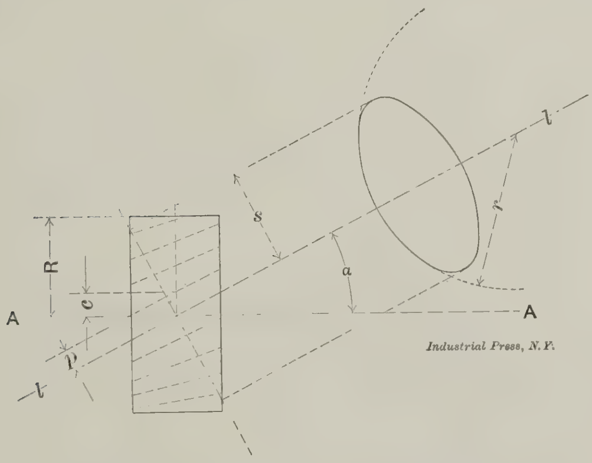


Fig. 2.

Equation (9) is derived similarly to (8).

Equation (10) is derived as follows: With notation as above,

$$\frac{2\,\pi\,R}{2\,\pi\,R'} = \frac{c \times N}{c' \times N'} \qquad (19)$$

which is an equation whose members are identities.

Adding numerators and denominators of each member of (19).

$$2\,\pi\,(R + R') = c \times N + c' \times N'. \qquad (20)$$

From Fig. 1 and Fig. 2 it is seen that

$$c = \frac{p}{\cos a} \qquad (21)$$

and

$$c' = \frac{p}{\cos \beta}, \qquad (22)$$

also $p = \dfrac{\pi}{D}$. (23)

Substituting p in (21) and (22),

$$c = \frac{\pi}{D \cos a}, \qquad (24)$$

and

$$c' = \frac{\pi}{D \cos \beta} \qquad (25)$$

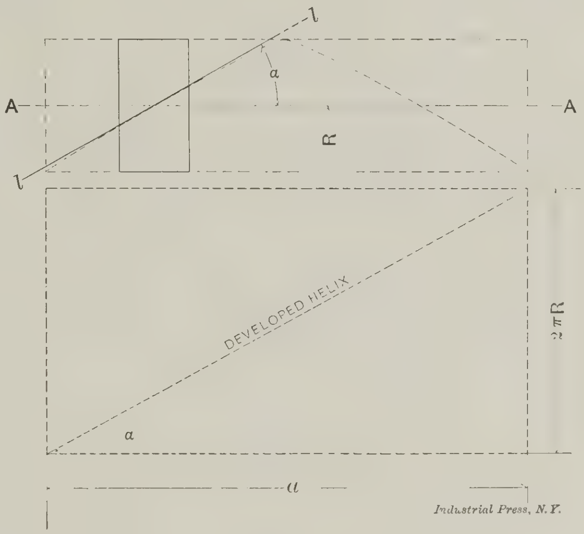


Fig. 3.

Substituting c and c' in (20),

$$2\,\pi\,(R + R') = \frac{\pi\,N}{D \cos a} + \frac{\pi\,N'}{D \cos \beta} \qquad (26)$$

Multiplying through by D, dividing by N' and π, and noting $R + R' = d$,

$$\frac{2\,D\,d}{N'} = \frac{1}{\cos \beta} + \frac{N}{N'} \times \frac{1}{\cos a}. \qquad (27)$$

Substituting $\dfrac{R'\,P'\,M'}{R\,P\,M} = \dfrac{N}{N'}$ in (27),

$$\frac{2\,D\,d}{N'} = \frac{1}{\cos \beta} + \frac{R'\,P'\,M'}{R\,P\,M} \times \frac{1}{\cos a}.$$

If the equipment of the shop was complete and there were no objectionable kinematic considerations, the simplest and perhaps the most efficient pair of gears would obtain when the tangent to the helices makes equal angles with the axes, However, the following considerations are important and condition the final data which is sent to the shop:

1. If the number of R. P. M.'s of each shaft is fixed, the ratio of the number of teeth is also fixed and there can be no fractional tooth.
2. A stock cutter must be used which approximates size of tooth designed.
3. Occasionally the gear shafts are fixed in position and consequently the distance between them is fixed.
4. The leads of the two spirals must be such as can be cut on a universal milling machine or some special gear cutter.

It is usually the case that all four conditions cannot be satisfied. Those in 1 and 2 are usually fixed. Those in 3 can often be changed in the early stages of a new design by changing the angle of shafts and the distance between them. Those in 4 can usually be met by making new gears for the machine which is used in cutting the spirals and it may be that it is quite possible to change the angle of teeth and distance between shafts so as to cut at least the lead of one of the gears with the regular change gears on the machine.

To illustrate the procedure for applying the formulæ used in determining the necessary data for the shop, a specific problem will be taken. Suppose there are two non-intersecting shafts making an angle of 60 deg. with each other when their axes are parallel with the plane of the paper; the driving shaft makes 70 R. P. M. and the driven shaft 120 R. P. M.; the shortest distance between axes will be taken tentatively as 12 inches; and a 3-pitch cutter will be used.

We will assume that the angle of the teeth is the same for both gears, or 30 deg. Then substituting in formula (10),

$$\frac{2 \times 3 \times 12''}{N'} = \frac{1}{\cos 30^\circ} + \frac{120}{70} \times \frac{1}{\cos 30^\circ} = 3.134''$$

$N = \frac{72}{3.134''} = 22 +$ which indicates that the teeth on the driven gear should be somewhere in the vicinity of 22. It is at once seen that

$$\frac{4 \times 12}{4 \times 7} = \frac{48}{28} \text{ and } \frac{3 \times 12}{3 \times 7} = \frac{36}{21}$$

both of which can be used. Since $N' = 21$ in the last equation is nearer to 22 we will use it. Keeping the angle as before and substituting again in (10) and solving we have

$$d = \frac{3.134 \times 21}{6} = 10.969''$$

which is the required distance between shafts.

Since the pitch radius of one gear is 10.969 minus the pitch radius of the other, by substituting $10.969 - R$ for R' in (5) and solving we have

$$R = \frac{12 \times .866\,(10.969'' - R)}{7 \times .866} = 6.928''$$

and

$$R' = 10.969'' - 6.928'' = 4.041''.$$

The leads of the spirals of the gears are found in (8) and (9) respectively.

$a = 2 \times 3.1416 \times 6.928''$ (tang $60^\circ = 1.732$) $= 75.393''$.

$a' = 2 \times 3.1416 \times 4.041''$ (tang $60^\circ = 1.732$) $= 43.983''$.

If the spirals are cut on a Brown & Sharpe universal milling machine, we find that gears 100, 40, 72, 24 on worm, 1st on stud, 2d on stud, and on screw respectively will cut a spiral with a lead of 75 inches, and gears 100, 40, 56, 72 on worm, 1st on stud, 2d on stud, and on screw respectively will cut a spiral with a lead of 43.75 inches. These two results are unusually close for a chance pair of gears. If we consider the inaccuracies and imperfections which result in the setting of the shafts, in the use of the unsuitable stock cutter, and in the setting of the cutter tangent to the helix, the probabilities are that the gears are practically all right without any change.

The outside diameters of driver and driven are:

$2 \times 6.928'' + \frac{2}{3}'' = 14.522''$ and

$2 \times 4.041'' + \frac{2}{3}'' = 8.748''$ respectively.

The number of teeth in driver is from (6)

$$n = \frac{36}{\cos^3 30^\circ = .649} = 55 +$$

and a No. 2 cutter is to be specified. (The value of the cosine and its cube should be taken directly from tables found in hand books.)

The number of teeth in driven is from (7)

$$n' = \frac{21}{\cos^3 30^\circ = .649} = 32 +$$

and a No. 4 cutter is to be specified.

Occasionally the condition arises where there is a certain fixed distance between shafts as would be the case if a pair of spiral gears replaced some previous driving mechanism in a machine whose shafts could not be changed without great expense. Suppose in the problem above everything was as given except that the distance between shafts must be exactly 12 inches. Our procedure then would be to try equal angles between tangent line and axes and substitute the rest of data in (10) as before. We found above that equal angles gave us fractional teeth which indicates that we will have to change the angles and use the next lower number of teeth that will give the proper ratio which is 36 and 21. (If we had used in this case 48 and 36 we would not have been able to satisfy equation (10). The left-hand member of the equation then is constant and its value

$$\frac{2\,d\,D}{N'} = \frac{2 \times 3 \times 12''}{21} = 3.428''$$

will, by method of trial and error, have to be satisfied by changing α and β in

$$\frac{1}{\cos \alpha} + \frac{R'\,P'\,M'}{R\,P\,M} \times \frac{1}{\cos \beta}$$

until the two members of equation (10) are equal.

Three or four attempts may have to be made before the desired angles are found but very little labor is involved when tables of natural cosines and reciprocals are used. The angles α and β which satisfy the equation are found to be 44°-10′ and 15°-50′ respectively.

The diameters of gears, numbers of cutters, and leads of spirals will again have to be found in the same manner as before, to meet the changed conditions. In the last case if the leads are such as cannot be cut by the use of the regular change gears on the universal milling machine, the only recourse is to make new change gears.

In a design of a pair of spiral gears sound conclusions which are the result of theoretical and practical investigation point to the fact that the efficiency of a pair of spiral gears is very appreciably reduced by too low angles of the spirals, and by too low or too high (generally too low) velocities of the rubbing surfaces. When there is a choice in the angle of a pair, equal angles for both gears should be used. The proper velocity of the rubbing surfaces are a function of the following: The load on the tooth and thrust bearings; the materials of which the gears are made; the condition of the surfaces; the lubricant used; and the arc of action which will vary with the angle of teeth.

Although there is limited data of experimental velocities with worm gearing there seems to be a dearth of proven data for spiral gears with varying angles. It has been stated that Mr. Wilfred Lewis recommends that a general average pitch line speed should be from 200 to 300 feet per minute. In all probability there is more difficulty in the design of a durable tooth than in the design of a strong enough one. However, the normal pitch of the teeth must be selected and in any one design it is a function of the magnitude of the load normal to the teeth, the length of tooth, arc of action, shape of tooth, and velocity.

By substituting the proper values in Mr. Wilfred Lewis' expression $W = s\ p\ f\ y$ (found in July Supplement to MACHINERY), and dividing p by 2, a pitch will be found which will meet the average requirements. It is to be noted that the factor, y, in the expression, relates to the number of teeth which in spiral gears should be taken along the normal helix as found in the expression $n = \frac{N}{\cos^3 \alpha}$.

In conclusion it may be said that when spiral gearing are properly designed, well lubricated, and run at an efficient speed, they should not be condemned as often as the traditional faddishness of some and conservatism of others seem to demand.

* * *

NEW PLAN FOR IRRIGATION.

Many thousands of acres in the arid regions of the West may be improved by irrigation, but the cost of irrigating canals and leveling the land is something enormous, especially the latter. *Forestry and Irrigation* says that a Wisconsin man has made a valuable contribution to the practice of irrigation in humid regions, and the same applies to arid regions. His method of applying the water to the fields is to convey it to the higher points in a sluice hose, perhaps 15 inches diameter, made of oiled duck with lateral ports which discharge into furrows. The sluice hose may be moved wherever required. Thus no land is required for ditches, and there is no expense for leveling. Less water is wasted than where ditches are employed and the water can be delivered where it is wanted and in any quantity desired.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A railroad has been built from mines near Gellivare, Sweden, to Ofoten, on the coast of Norway, which is said to be the most northerly railroad in the world. It was constructed by English capitalists, who wanted a supply of Swedish iron the year around.

The bronze propellers of the twin-screw steamship *Kaiser Wilhelm II.*, are 22 feet 10 inches diameter. Each propeller is driven by two four-cylinder, three-crank quadruple expansion engines of 20,000 horse power, making the total propelling force of the vessel 40,000 horse power.

The firm of Robert Poole & Son Co., Baltimore, Md., recently cast a gear wheel weighing 65,000 pounds. The teeth of this gear, as of practically all the gears made by this company, are of the epicycloidal form. Since casting the heavy gear they have cast a smaller one having a pitch diameter of about 9 feet and only 31 teeth. The circular pitch is 11 inches—the largest they have ever made.

As a test of what a modern battleship might do in times of emergency or war, the U. S. S. Kearsarge, recently with the European squadron, was directed to cross the Atlantic under full speed, with natural draft. She arrived at Bar Harbor, Me., in perfect condition, having traversed 2,900 miles in nine days, four and one-half hours, at an average speed of 13.1 knots against variable head winds. Enough coal was left to have continued 1,000 miles further.

In mining operations it would naturally be believed that masses of pure metal could be more profitably worked than any other form of deposit, but such is not the case with copper. In the Calumet and Hecla copper mines in Northern Michigan, great masses of pure copper have been found, and it has proven very expensive to handle on account of the great difficulty of working it with tools and the impossibility of breaking it up by blasting. One mass of over 500 tons of virgin copper was such an expensive undertaking to remove that it was a debatable matter whether it would not be more profitable to abandon that section of the mine for other portions that could be worked easier and more profitably.

In a paper read before the American Foundrymen's Association at Milwaukee, Wis., June 9-11, by W. E. Dickson Sharpsville, Pa., it was stated that pig and cast iron borings lose perceptibly of their sulphur contents after standing for some time, even if contained in sealed bottles. The phenomenon is not noticed in steel turnings, and the difference is attributed to the fact that in cast iron borings every particle is cracked throughout so that a large surface is exposed to oxidizing influences; the steel borings or turnings roll up into a compact mass without cracks, so the surface exposed to the atmosphere is relatively much less.

The production of platinum from domestic ores in the United States decreased from 1,408 ounces, valued at $27,526, in 1901—the largest output recorded—to 94 ounces valued at $1,814. The domestic supply of platinum in recent years has been obtained as a secondary product chiefly from gold placer deposits in Trinity and Shasta Counties, California. It is reported that the metal occurs, though not in commercially rich deposits, in many other gold placers of California, as well as in Washington, Oregon, Idaho, Montana, Colorado, and Alaska. The Russian sources of platinum supply, which furnish about 90 per cent. of the total consumption of the world, are comparatively limited. The imports of platinum into the United States during 1902 were valued at $1,987,980, showing how small a percentage of the quantity used is obtained in this country from our own mines.

Electric automobile chairs will be one of the features of the World's Fair at St. Louis in 1904. The chairs will have a uniform speed of three miles per hour, the operator having no control over the speed. The chair takes the form of a low phaeton without a cover. There are two large rear wheels and two small ones under the foot rest, all pneumatic-tired. On the inside of the chair, attached to the arm, is a lever, which puts the chair in motion or stops it at the will of the rider. A long lever attached to the front truck has its handle directly in the center of the chair and is used for steering. A feature of the machine is a "sensitive rail" which surrounds the chair on all sides, save at the rear. This prevents any accidents, for when the rail comes in contact with any object, even though it weighs but a pound, it presses against a device that locks the wheels and brings the chair to a dead stop.

The retirement of Rear Admiral Melville from his active duties as Chief of the Bureau of Steam Engineering and Engineer-in-Chief of the United States Navy, through the government requirements as to age limit, brings to a close a remarkable career in the public service. The Rear Admiral is only 62 years of age and is vigorous, so that it is to be hoped he still may have special commissions to carry out for the government and that his ripe experience may often be drawn upon in the advancement of sound engineering principles, progressive, yet conservative, for which he has always stood. It is to be regretted that he could not have remained at his post a few years longer now that the advent of the water-tube marine boiler is at hand and the possibility of the steam turbine for naval vessels may shortly be realized. Admiral Melville began his duties as engineer at a time when the only modern vessels of the navy were the original John Roach ships of the white squadron, having a speed of from 14 to 16 knots. From this small beginning he has directed the engineering features of our whole navy, and these constitute the splendid and unusual record of his more important engineering work. He was a member of the engineer corps during the civil war, and later had many thrilling experiences in connection with several Arctic expeditions, among them the search for the missing crew of the ill-fated *Polaris* and as an engineer officer of the tragic expedition of the *Jeanette*. At present Admiral Melville may be regarded as one of the three or four engineers who are at the head of the engineering profession in its various branches.

The destruction by fire of a train of cars in the subway at Paris, France, last month, and the deplorable loss of life in consequence, has led people of New York City to speculate on the possibility of a similar catastrophe in the new subway of this city. In commenting on the event the *Street Railway Journal* says:

The most conspicuous feature of the new subway cars, which are being built for the New York subway, is the precaution taken to guard against accidents through fire, collision or derailment. The cars were built unusually strong, and were designed especially with the view of withstanding heavy impact. The plans for the electrical features were also made to provide against the possibility of fires from defective wiring, faulty insulation and improper installation of apparatus. A careful study of car construction in European cities, especially with reference to tunnel operation, was undertaken at an early stage, and an earnest effort was made to avoid the defects which have been revealed in former installations. The New York subway management has profited by the experience of the London and Paris companies, and those who are best qualified to judge say that such a disaster as the Paris conflagration could not be repeated in this city. Not only has every effort been made to insure safety by employing fireproof material, including a copper sheathing for the car body, but the tunnel construction and equipment show marked advance. Moreover, the lighting service is entirely independent of the power supply for the operation of the trains, a condition that did not exist in Paris.

THE VARIOUS EDISON INDUSTRIES.

A recent issue of the *Electrical Review* contains a description of the Thos. A. Edison works at West Orange, N. J., where are located Mr. Edison's laboratory and experimental departments. While Mr. Edison's fame as an inventor is world-wide and his name is probably known by more people than that of any other living inventor, we doubt whether people are generally familiar with the fact that Edison is also a large manufacturer. There are several Edison plants in New Jersey, turning out a variety of products and in large quantities. At the West Orange works are manufactured nearly all of the parts of the various machines made for the different selling companies which represent the Edison interests. Here are made the stampings and turnings for the Bates and Edison numbering machines, fittings and appurtenances for the Edison phonograph, the Edison kinetoscope apparatus, and some of the material which goes into the assembling of the Edison primary battery and the Edison primary battery fan motor. While the primary battery is assembled at the works at West Orange, the manufacturing of the parts is mostly all done at Silver Lake, N. J. The manufacture of these several products constitutes an immense business, as can be judged when it is considered how many Edison phonographs alone are in use in every part of the country. There is still some experimenting being done on the Edison storage battery at the West Orange works, but the machinery, outside of the experimental machinery, is being put up and placed in operation at Glen Ridge, N. J. Mr. Edison is also interested in Portland cement works, and experimental machines for them are being constructed at the experimental department at West Orange, but the heavy machinery and manufacturing equipment for this plant are located at Stewartsville, N. J.

SLEEPING CARS FOR ELECTRIC LINES.

The development of interurban electric lines in all parts of the country, and particularly in the Central West, is becoming nothing short of remarkable. The convenient service which such roads are able to render, the cheap fares and reasonably quick running time; the frequent stopping places, the neat and attractive cars, and the ability of the cars to enter the various towns and cities on the tracks of the regular street railways render the interurban lines justly popular. That they are to encroach still further upon the domain of the steam lines is evident from the fact that preparations have been made for sleeping cars on some of the interurban roads where the length of run is sufficient to make them profitable. It is expected that the new sleeping car service will be patronized largely by traveling men, who find the schedules of the older roads inconvenient for travel by night. These roads run their best trains for the benefit of through traffic, and their times of departure from many cities, midway between main destination points, is at almost any inconvenient time of the night or early morning. A traveling man has to work and work hard daytimes, and does not like to take a train at two o'clock in the morning and lose half a night's rest in order to be on hand for business at the next station the following day. The Holland Palace Car Company, Indianapolis, Ind., has recently been organized for building sleeping cars for electric lines. Their car differs radically from the Pullman design, but may be used, like the Pullman car, as a day coach as well as a sleeper. All of the partitions are made on the principle of the roller top of a roller-top desk, and slide down between the double floors in the daytime. These partitions are in front of the berths, as well as at the ends, except for a narrow opening for entrance and exit, which is covered by a portiere. The berths are 27 inches wide, and there are 15 inches between the edges of the berths and the front partitions, giving standing room within the compartment itself. Two cars are nearly finished and will be used on lines in Ohio and Indiana.

LARGE TURBINE PLANT.

The *Western Electrician* states that the Edison Electric Illuminating Co., Boston, Mass., is about to erect on L Street, South Boston, a new electric light station, which, when completed, will constitute one of the most important and, in point of equipment, one of the most modern in the country. The particular feature of interest is that turbine units are to be installed instead of reciprocating engines, coupled to generators.

The station, consisting of a boiler room, turbine room and switchboard room, will be built upon the "unit" system, comprising 12 distinct units, each of which will have its own steam and electrical equipment, as well as individual auxiliaries, so that each unit will be virtually a station in itself, arranged to run independently or in conjunction with any or all of the others. These sections will be built and added to from time to time, as the increasing business of the company requires, until finally the building will cover an area about 650 feet long and 250 feet broad, which is nearly four times the area occupied by the present station building, while the plans call for an ultimate equipment in boilers equal to an engine capacity of 96,000 horse power, and an electrical capacity of 60,000 kilowatts, which, together with the 9,000 kilowatts already installed in the old station, will provide a total of 69,000 kilowatts (or 92,000 horse power), available from the L Street station.

The installation will consist of Babcock & Wilcox boilers, rated at 500 horse power each, and 5,000-kilowatt General Electric steam turbines, to each of which will be direct-connected one General Electric, three-phase, 60-cycle, 6,900-volt generator of the same capacity. To facilitate the handling of heavy pieces of machinery, there will be installed, in the turbine room, a 50-ton electric traveling crane. The walls up to the level of the crane track will be lined with tiles, while the space above will be finished in fancy brick.

Beneath the turbine room, running its entire length and extending to the water of the channel, will be constructed three brick-lined tunnels, two having a diameter of 8½ feet each, for the intake of water for condensing purposes, and one 10 feet in diameter for its discharge. The lower inside surface of these tunnels will be about 30 feet below the level of the floor, and their construction will require, to a certain extent, the same class of engineering necessary in the building of the East Boston tunnel. Towering above the station, one common to each consecutive pair of units, will be seen six graceful chimneys, 250 feet high, each 25 feet in diameter at the base and with a minimum internal diameter of 16 feet.

THE EDISON BATTERY.

At various times adverse comments upon the Edison storage battery for automobiles have been made by writers in the technical press, and we remember a discussion by one electrical engineer who demonstrated to his own satisfaction, and perhaps to others, that the battery simply could not be any better than any of the lead storage batteries on the market, for the reason that it was no better in principle, and in fact had serious faults of its own. Time alone will prove the truth or falsity of this assertion, but be it said that Edison himself has full confidence in his battery and his confidence apparently is based not only upon theoretical grounds but upon practical results of extended trials. Reporters of the *New York Times*, the *Newark (N. J.) Evening News* and the *Electrical Review*, New York, have recently interviewed Edison upon the subject. Edison contends that American automobiles are not built substantially enough for hard usage and at present is about to construct four automobiles complete, modeled along French lines, but equipped with electric motors and his batteries instead of with gasoline motors. With these he expects to be able to subject his batteries to even harder and more severe tests than they have yet had.

The following points were brought out by the reporters: There are now three heavy trucks operated by current from the Edison battery. One is a two-ton truck which formerly had over 1,200 pounds of lead battery. It is now equipped with about half this weight of the new battery, which will carry the truck 35 miles before the voltage begins to fall off. In one test a battery was used in a runabout for a distance of 5,000 miles, being recharged over and over again with electric current and at the end showed no deterioration of its component parts, and appeared to be good for an indefinite amount of use. At present one set of batteries is being made a day. Recent improvements enable the battery to be charged even more rapidly than possible with the earlier types, which had rapid charging as one of their characteristics. This has necessitated changes in the fixtures and machines for manufacture. Another difficulty in putting the battery on the market has been the trouble in getting the kind of sheet metal needed. This is now imported, under a heavy duty, but a rolling mill will be in operation in this country this fall for its production. The present cost of the battery is fixed at $15 a cell. Four cells are required per horse power hour, and twenty-one cells are installed in the ordinary runabout machine, which they will drive for 81 miles on a single charge. Thirty-eight cells will drive a machine weighing one ton 60 miles, and a delivery wagon weighing two tons will go 36 miles on one charge of thirty-six cells. Mr. Edison confidently predicts that within a few years the gasoline machines now in use will be entirely replaced by machines driven by electric motors actuated by his batteries.

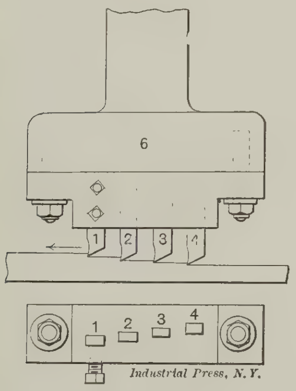
THE BIGGEST HARVESTER IN THE WORLD.

World's Work, August, 1903.

Last year there was in operation in the San Fernando Valley of California the largest combined harvester in the world. It consists of a traction engine capable of hauling seventy-five tons and which takes the place of sixty horses; a header or mowing machine which cuts a thirty-six foot swath, and a complete threshing machine. The header and threshing machine are run by a separate thirty-horse power engine getting its steam from the same boiler as the threshing engine. The drive wheels of this monster traction engine are eight feet in diameter, with tires forty-eight inches wide on which are ridges an inch and a half high. It can average three and a half miles an hour in good grain. The thresher has a capacity of 100 acres a day. Eight men are employed on the thresher. The grain is threshed clean and finally carried to a bin from which it is sacked. When twelve sacks have been filled they are allowed to slide off the cart to the ground. This huge machine will work equally well on level or hilly country, having sufficient power to take a twenty per cent. grade without difficulty. It is sixty-six feet long, half as wide, and weighs more than 100 tons. Oil is used as fuel. This harvester has been successfully used for shelling peas and beans as well as grain. It is purely a Californian production.

GANG PLANING TOOL.

Zeitschrift fur Werkzengmaschinen und Werkzenge, January 15, 1903, p. 163.



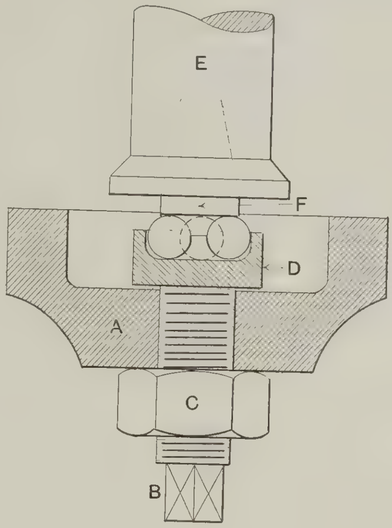
Gang Tool.

The gang cutting tool has gained for itself a prominent place in German shop practice, and the accompanying illustration shows one that is doing good work. The construction will be readily understood from the drawing. The cutting tools 1, 2, 3 and 4, are inserted in the holder and fastened by setscrews. The holder itself is attached to the tool post or carriage by bolts, thus making it possible to remove and replace it with great ease and rapidity. By this means the cutters can be taken away and ground to the proper dimensions and shape without disturbing them in their position.—G. L. F.

A STEP BEARING.

Zeitschrift fur Werkzengmaschinen und Werkzenge, January 15, 1903, p. 158.

This step bearing is acting very satisfactorily upon a number of vertical shafts running at high speeds on woodworking machinery. It consists of a cup-shaped base, *A*, which is integral with the frame of the machine. This base is threaded for the screw *B*, which is fastened by the check nut *C*, and serves to support the cup bearing *D*, in which the balls are placed. The spindle *E* rests upon these balls through the intervention of a hardened steel bearing block *F*. This latter is let into the spindle with a taper fit and is driven home. The arrangement thus provides a ball bearing for the foot of a spindle with a vertical adjustment that can be made at any time without difficulty, while the actual bearing parts admit of quick and ready renewal.—G. L. F.



Ball Step Bearing.

TEST OF HIGH-SPEED TOOLS.

L'Echo des Mines et de la Metallingiè, February 16, 1903, p. 185.

Some interesting tests have recently been made by Yarrow & Co. with drills made of common and special tool steel, for the purpose of ascertaining the maximum speeds at which they can be run, their relative endurance and the power required to drive them.

It was found that the common steel could not be run at a speed greater than 76 revolutions per minute with a feed of 1-200 inch, while the special steel could be run at a speed of more than 100 revolutions. The relative endurance of the two classes of drills was estimated from the increase of power required to drive them after a certain amount of work had been done. It was found that, with the special steel, there was an increase of 8½ per cent. in the amount of power required to drive them after thirty holes had been drilled at a speed of 96 revolutions per minute, while, in the case of the drills made of common steel running at 76 revolutions per minute, an increase of 37¼ per cent. was required.

It was found that drills 1¾ inch in diameter could be worked in soft steel at a speed of 100 revolutions per minute without difficulty. Hence, in order to obtain the most economical results in drilling, a special steel must be used.—G. L. F.

TRAIN RESISTANCE AT HIGH SPEEDS.

Zeitschrift fur Electrotechnik, March 1, 1903, p. 127.

In a formula worked out by Herr J. Davis he considers that: 1, the friction of the journals is independent of the speed; 2, the friction of the rails is in proportion to the speed; 3, the air resistance is in proportion to the square of speed and is also dependent upon the shape and size of the car and the number of the same in the train.

Experiments were made with a train consisting of a locomotive, a brake van and four cars, noting the results obtained with the locomotive alone, the locomotive and one car, the same with two cars, etc.

The curves that have been plotted from these figures may be represented by the formula:

$$S = \frac{4 + 0.13V + 0.004AV^2\,[1 + 0.1\,(n-1)].}{T_1}$$

where

S = the train resistance in horse power per ton;
V = the speed in miles per hour;
A = the cross sectional area of the car in square feet;
n = the number of cars in the train inclusive of the locomotive.—G. L. F.

HIGH-SPEED STEELS AND THEIR USE FOR CUTTERS OF COMPLICATED SHAPE.

Abstract from paper read by Edmund L. French before the American Society for the Advancement of Science.

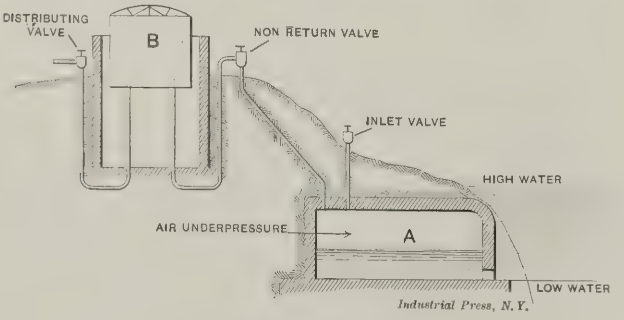
These high-speed steels have worked a complete revolution in modern engineering, necessitating the building of new and more powerful machine tools, and nearly doubling the output of shops where they have been adopted. All the best makes of high-speed steels show ability to withstand the heat engendered in heavy lathe and planer work to such a remarkable degree that it is a common sight in machine shops where the latest high-speed steels are used to see a tool doing heavy cutting work with that part of the steel where the chip curls off actually red hot. Here comes in the distinction between a plain carbon steel and the high-speed self-hardening product. When a tool made of the former becomes so heated by work as to show the temper colors, it softens, and the cutting edge is quickly rubbed off, while a high-speed tool similarly heated retains sufficient hardness to do the work required.

Until recently the extensive use of self-hardening steel has been confined to extremely simple forms of tools, where all the work necessary to fit them for service could be done by forging and grinding to shape. Now, however, there have been perfected processes of annealing which admit of self-hardening steel being as easily machined as most of the ordinary carbon grades. The high-speed qualities of the steel, as found in lathe and planer tools, can thus be utilized for cutters of all kinds, complicated or simple in pattern, at a great saving of time through the increased amount of work such tools are capable of turning out. The greatest advantage, however, which such a steel possesses over the ordinary water-hardening varieties lies in the fact that there is absolutely no danger of loss in the hardening bath, where so many costly tools meet their end, for it is only necessary to heat such a steel to redness and lay it aside to cool, when it will have regained the hardness it possessed before annealing.

MEANS FOR UTILIZING THE POWER OF TIDES.

Compressed Air, July, 1903, p. 2460.

The plan of Mr. Charles Eugene Ongley, of Mons, Belgium, for utilizing the power of tides, is to build a subterranean chamber at right angles to the shore line which shall be connected with the ocean by an opening at the low water line and low in height as compared with the rise of the tide and the total height of the chamber. The rise of the tide by virtue of this construction, imprisons air in the chamber and subjects it to pressure which depends upon the difference in height between the tide level and the level of the water in the chamber. Thus if the high tide level were six feet higher than the level of the water in the chamber the pressure per square inch would be approximately three pounds. This pressure, while comparatively slight, can be raised to higher pressures by means of accumulators working on the well-known principle employed in hydraulic accumulators for presses, riveters, etc. In the cut, *A* is the subterranean chamber communicating with the sea. The roof of this chamber is supposed to slope upward away from the water so that the imprisoned air has free access to the pipe leading to the air-holder *B*. This air-holder works on the same principle as the well-known gas-holder and serves to store the power and distribute it over those periods when the tide is falling, etc. The chamber *A* need not necessarily be located immediately at the water's edge; it may be connected with the sea by a suitable tunnel as well.



Compressing Air by the Tide.

TEST OF DIFFERENT METHODS OF JACKETING LOCOMOTIVE BOILERS.

Revue Generale des Chemins de fer, February, 1903, p. 91.

A series of experiments, made at the shops of the Paris, Lyons & Mediterranean Railway, on the radiating qualities of different methods of jacketing boilers, shows that in the matter of the influence of surface on heat radiation as far as the metals themselves are concerned either dull or polished brass is to be preferred to any of the others. It was also found that polishing makes a sensible diminution in the amount of heat radiated, and thirdly, that if a coat of paint is applied, the character of the sheet has no influence whatever. The radiation is governed by the painted surface only, and the loss is considerably greater than with the bare surfaces.

The work also included tests of different methods of jacketing in calm air as well as where there were currents.

The bare jacketing radiated less than the painted, the difference being from 55 to 185 heat units per square foot of surface per hour. In calm air and under the same conditions, a single jacket of mineral wool radiated about one-half as much heat as a bare jacket, and one-third as much as a painted one. Where a double layer of mineral wool was used, the losses per square foot were about one-half as much as they were in the case of the single layer.

With a double jacket and a layer of mineral wool between, the losses were about one-half as much as they were with a single jacket without the wool.

It was found that in air currents when the velocity was greatly increased the losses were doubled, and that a layer of mineral wool reduced these losses by one-half. The effect of painting is to increase the loss but not to so great an extent as in calm air.

A further test was made of pipe coverings, using a copper pipe 7 inches inside and 7½ inches outside diameter and about 7 feet high; the comparison being made with a bare pipe and one having a brass jacket enclosing a covering of one or more thicknesses of corrugated paper, the whole being wrapped with a sheet of tarred paper.

The results obtained in condensation of water per hour under the same conditions, the pipe being vertical, in free contact with the air and connected to a boiler carrying a pressure of 213 pounds per square inch were as follows:

	Pounds.
Bare pipe	25.3
Pipe with special covering	15.4
Pipe enclosed in brass jacket	16.5

G. L. F.

DEVELOPMENT OF TOOL STEEL.

Edmund L. French before the American Association for the Advancement of Science.

The author stated that the hardening of steel dates back to the remotest antiquity, the name of the original inventor or discoverer having been lost to the world. The ancient Egyptians made a low grade of steel capable of being hardened by heating meteoric iron for a long time in the forge, during which period it absorbed sufficient carbon from the fuel to harden when plunged into water. The metal-workers in the dark ages also hit on the same discovery and this was the actual birth of the steel industry and the beginning of the development of the crucible process.

The progress of steel-making as an art, until within the last two hundred years, was slow but gradual. Weapons of war and rough implements for tilling the soil were for centuries fashioned by skillful smiths who worked at isolated forges, and who guarded their mysterious secrets carefully and well. Gradually, however, as a demand grew for fine swords and armor of steel, axes, knives, and other tools, these steel workers formed themselves into colonies for trade purposes at places where good iron could be easily obtained, and the industry developed to a commercial scale. Notably in Austria and England this centralization took effect, and in the city of Sheffield large furnaces were in operation in the seventeenth century for the conversion of Swedish and Norwegian iron into blister steel by the cementation process.

This process was essentially the same as that employed by the ancient workers of iron, but on a larger scale, with furnaces especially built affording facilities for converting the pure iron bars into steel in quantities which soon made the industry an important one. Although the industry grew rapidly, and the product was of such a quality as to permit of the manufacture of the finest tools, these old steel makers worked on a "hit-or-miss" plan, with no clear idea of the way and wherefore of their process. A steel was obtained which had uncertain percentages of carbon, higher on the outside than on the inside, and varying in hardness from one end to the other, according as the bar came in contact, in the converting furnace, with more or less of the carburizing material or a higher or lower degree of heat.

It was not until about 1730, when Huntsman, of Sheffield, the inventor of the crucible process, began to make his experiments, that the industry was actually born. Huntsman's invention grew out of the necessity for a more uniform product than that afforded by the cementation process alone—in fact, for a metal of absolute homogeneity. He conceived the idea of cutting the blister bar in pieces and melting it in crucibles to get a uniform carbon. The charge was then allowed to cool and the crucible broken away from the mass of steel, which was used as an ingot. Molds for casting the metal were subsequently introduced, thus saving the crucible for further use.

Huntsman's process of melting materials in crucibles was not new. His invention really consisted in successfully solving the great difficulties met in applying his process to the actual production of steel, and it is thought probable that his knowledge and skill in producing crucibles of a sufficiently refractory nature to withstand the high heat required, were responsible for his success. The new process developed by Huntsman, and improved on by such men as Jessop, Mushet, Lucas, Sanderson, Spencer, and others, soon gave to England the first rank among steel-making nations, and made the name Sheffield a synonym for the best that was known in the form of a razor, a knife, or a bayonet.

Then the crucible-steel industry was started in other countries, but there have been no important changes in the essential processes of crucible-steel manufacture. An advance over the use of the cemented bar has taken place in the American practice largely in vogue of using a highly carburized and very pure iron, called washed metal, as a vehicle for introducing carbon into the steel, giving more regular percentages than can be obtained by the use of charcoal, and lowering the cost of making without any deterioration in quality.

It is along the line of special steels or alloys made in the crucible that the greatest advances have taken place. The makers of the old-fashioned crucible steel found that when they had produced a material with the highest amount of carbon possible, quality being at the same time of the best, they had reached the limit of cutting power in tools, and competition made it necessary for each maker to attempt something to excel his neighbor's product.

The first great advance was made by Mushet, who succeeded in melting with his charge of steel the mineral "wolframite," which gave him certain regular percentages of tungsten and manganese. The steel so produced had the peculiar property of being "self-hard"—that is, of requiring no heating and subsequent cooling in water to induce hardness. It had also an ability to withstand the heat developed by friction in cutting work, and the product, called "mushet," which name is still used in some localities to designate this variety of steel, became a recognized institution. As soon as the chemist found out the ingredients of this new steel, the various makers began to imitate it.

Tungsten metal and ferro-tungsten were later made to facilitate the manufacture, and gradually chromium, molybdenum, and other metals were employed in the production of this class of steel. Even uranium, titanium, and vanadium are used to some extent to-day as ingredients of special crucible steels. A large variety of combinations of iron and carbon with tungsten, chromium, manganese, nickel, silicon, or molybdenum characterize the special steels on the market to-day. Every maker furnishes, besides his regular carbon steel, a self-hardening steel and an intermediate grade which may be called a semi-self-hardening. The latter is capable of being hardened in water without cracking, and suited for extremely hard cutting. The self-hardening steels cannot be brought in contact with water while hot on account of the danger of cracking. Some of the milder grades rely on the assistance of an air blast, after forging, to give them the proper degree of hardness for their work, and are called "air-hardening steels."

It was thought for years that the greatest degree of perfection and the limit of cutting power had been reached in the best self-hardening steels, but within the last three years new products, similar in character and analysis, have been perfected, with capabilities of high-speed work which far surpass the old. Many of the latter steels owe their high-speed qualities to special heat treatments given the tool after forging, while some of the newer products are of such combination chemically that no treatment, or only a simple one, is necessary.

TESTS OF THE RATEAU STEAM TURBINE.

Street Railway Journal, July 25, p. 118.

The steam turbines designed by Prof. A. Rateau, Paris, France, and manufactured by the Oerlikon Machine Works, Switzerland, and Sautter, Harlé & Co., France, are assuming a prominent position and appear to give good results. Their operation is similar in principle to the Curtis turbine in this country. In his tests Rateau determines the efficiency from the ratio of the real steam consumption to the theoretical consumption of an ideal machine. The theoretical steam consumption is defined as corresponding to the maximum work which the steam can produce under the conditions under which it is delivered to the machine, by expanding adiabatically and without losses, from the initial pressure to the exhaust pressure. Prof. Rateau shows that the theoretical consumption depends largely upon the pressure in the condenser, as shown by the following example:

If a machine using saturated steam at a pressure of 213 pounds per square inch exhausts into free air, the theoretical steam consumption is 12.85 per horse power hour. If, however, the same machine be provided with a condenser which reduces the exhaust pressure to 27 inches the theoretical steam consumption is only 7.82 pounds, i. e., 39.3 per cent. smaller than before.

Following are the results of some tests of a turbo-generator of 540 electric horse power, which is one of a group of three similar machines made in the Sautter-Harlé works for the Penarroya mines in Spain, where they have just been installed. Each set consists of two turbines of high and low pressure, and two direct-coupled direct-current dynamos, giving each at normal load 830 amperes at 220 volts. The normal speed is 2,250 revolutions per minute. These turbines operate condensing, with "ejector" condensers of the Rateau type. The boilers supplied steam under a working pressure of 140 pounds to 210 pounds, maintained at the turbines by a reducing valve at 140 pounds per square inch as maximum. The consumption and the efficiencies are given in the following table:

TESTS OF RATEAU TURBINES.

	¼ Full Load.	½ Full Load.	Full Load.	Over-load.	Over-load at 2,400 r. p. m.
Electric horse power at the brushes	135	259	525	627	641
Working pressure at gage in lbs. per sq. in.	31.	61.	12.1	141	141
Absolute pressure in lbs. per sq. in. of exhaust	1.247	1.34	1.64	1.82	1.82
Theoretical consumption in lbs.	10.91	9.77	8.82	8.71	8.71
Actual consumption in lbs. in horse-power at the brushes	21.3	18.0	15.74	15.31	14.86
Combined efficiency of generating set	0.513	0.540	0.560	0.569	0.586

This table shows that the combined efficiency, i. e., that of turbine and dynamo together, varies between 51 per cent. and

58.6 per cent., while the steam consumption per electric horse power hour may be as low as 14.86 pounds. Also, that the combined efficiency of the turbo-generator is practically constant, the variations being not more than 8 per cent. between overload and one-quarter full load.

The efficiencies of turbines when a high vacuum is used suggested to Prof. Rateau the possibility of utilizing, by their means, the exhaust of steam from engines running at intermittent load, such as steam hammers, mine hauling and rolling mill machinery. In such cases to secure a continuous flow of steam to the turbine Rateau uses an apparatus which he calls a "regenerative accumulator of steam;" it consists of sheet-iron cylinders, containing a series of cast-iron plates, which condense the steam on its arrival from the prime mover and allow it to vaporize when the exhaust from the first machine stops. The pressure of the exhaust steam is nearly constant, and equal to about 3 pounds. An adjustable valve, regulated by hand, permits a variation within certain limits of the steam pressure from the accumulator; in general this pressure is from 2.8 pounds to 5.2 pounds.

A very interesting application of this principle has been made at the Bruay mines at Pas-de Calais. The exhaust steam of the hoisting machine is fed to a turbo-generator of 300 horse power. The test showed a production of 1 electric horse power per hour at the terminals of the generator, with a steam consumption of 39.68 pounds; the steam being admitted at atmospheric pressure and the vacuum in the condenser being 24.8 inches of mercury, hence, relatively bad. This figure Professor Rateau believes could be reduced to 28 pounds per electric horse power hour with a better vacuum in the condenser, which is perfectly obtainable in practice. Under these conditions the low-pressure generating set performed about three times as much useful work per pound of steam as the hoisting machine, even with a steam consumption of 30.68 pounds against 100 pounds, the ordinary figure for a simple non-condensing hoisting engine.

STEEL, AND STEEL AND CONCRETE TIES.

Railway and Engineering Review, August 1, 1903, p. 580.

Now that railway and government authorities have become thoroughly aroused to the question of future timber supply, any measure undertaken with a view to conserve this supply, increase the life of timber that is used for structural purposes, or substitute other material, wherever timber is in demand in large quantities, is necessarily a subject of a good deal of interest.

The thought of using iron or steel in substitution for wood in structural work comes naturally, and in foreign countries there is a large mileage of track laid with iron or steel ties. In this country experiments with steel ties, in years past, have been unsatisfactory, principally owing to the fact that the designs which have been tried have failed to properly support the track and to admit of surface repairs by ordinary methods of track work. The general rise in the price of steel a few years ago also had the effect of turning the attention of railway men from the use of this material for railroad ties. Within recent years a few men have proposed the use of concrete reinforced with steel.

The man who has labored most persistently along these lines, so far as we are aware, is Mr. C. Buhrer, roadmaster with the Lake Shore & Michigan Southern Railway, at Sandusky, O. Three years ago Mr. Buhrer laid some steel ties in the main track of this road at Sandusky, and a year later other ties of the same kind were laid on a curve in the main track at Sandusky Junction, about 2½ miles east of Sandusky, where the trains make full speed.

These ties have maintained the track in good surface, alignment and gage, with much less work than has been required for wooden ties under like conditions, and it has been unnecessary to disturb the embedment of these ties to make renewals, as is necessary with wooden ties each season. The piece of track laid with these ties bids fair to remain in first-class condition for many years to come, at an expense for maintenance which is very much less than that required for track laid with wooden ties.

Mr. Buhrer's principal aim in experimenting with these ties has been to ascertain their effectiveness as a track support, and to show a decrease in the amount of work necessary to maintain the track in surface and alignment. The test has proven that his expectations have been realized, and the facts are indisputable. The only remaining consideration of importance is the expense. Owing to the state of the steel market for several years past, Mr. Buhrer has not been able to get the rolling mills to undertake the manufacture of the ties by rolling them from old rails. This would be the desirable method of construction, as then the tie would be in a single piece, and, if they could be rolled out of scrap rails by reheating, without remelting, the same, the expense of manufacture would be a minimum.

In any event the tie could be rolled from new metal, and Mr. Buhrer is ready to demonstrate that, even when so made, the maintenance cost of track laid with such ties can be reduced to a figure much lower than the present cost with wooden ties, with a very satisfactory showing for the ultimate economy.

Mr. Buhrer's experiments with concrete for tie material were begun in June, 1902, when a few ties of concrete, reinforced with a piece of old rail molded in the top face, with the head downward, were laid in the main track of the L. S. & M. S. Ry. 2½ miles east of Sandusky, O., adjoining the steel ties above referred to. Later ties were laid on short lengths of other roads and in every case have proven satisfactory in all particulars. The reinforced concrete tie affords substantial bearing for the rail and a very secure arrangement for the fastenings. As the head of the rail projects downward into the body of the concrete the latter secures a very firm hold of the rail, and a strong and stiff tie is secured. It is fully understood that the use of old rails in these ties involves a good deal of metal, undoubtedly in excess of the requirements; but as the principal aim of the experiments was to determine how the concrete would bear up under the traffic and sustain the shock of rolling loads, the excess of metal was of minor importance. The inventor has in view the possible use of various metal shapes for the top face of the tie, such as old rails of lighter weight than the ones used, which weigh 60 pounds to the yard; T-irons, bulb irons, a channel with the flanges downward, and other shapes.

Mr. Buhrer has made a careful study of the concrete mixture required for tie material, and the result has been a selection of sizes and proportions differing somewhat from ordinary practice in general concrete construction. Methods of mixing and molding have also been evolved to suit the requirements of the material. The experiments cover the use of both fine gravel and finely crushed stone as ingredients of the concrete mixture. After setting 30 days the concrete of these ties is remarkably strong and hard, and will bear smart blows from a sledge hammer without fracture. The ties are unloaded by being thrown from the cars. The only precaution taken is not to let one tie fall across another. Mr. Buhrer says he has no fear of damage to the ties so long as they do not strike anything harder than the ground, and from tests of the material made in our presence it does not appear that they are an article requiring delicate handling. The track laid with these ties can be raised and tamped with bars or picks equally as feasible as track laid with wooden ties, and a misdirected blow or "lick" from a tamping bar does not "faze" the material.

ENGINEERING FEATURES OF A GREAT DEPARTMENT STORE.

Insurance Engineering, July, 1903. p. 27.

The department store of Marshall Field & Co., Chicago, is the largest retail establishment of the kind on this side of the Atlantic and there are only two larger in the world, those being in Paris. The total floor area of the Field store is 1,000,000 square feet, which is about one-third larger than the area of the new Macy store in New York City. The store is composed of several sections, or buildings, one of which, recently constructed, is 12 stories high. Seven thousand people are employed.

There are 53 elevators, of which 41 are for passenger service, all of the improved electric type, operated in most cases by a 35 horse power motor for each. The motors are all located in the attic, so that no space is occupied in the basement by elevator machinery. The passenger elevators have a capacity of 3,000 pounds each at 350 feet a minute and the freight elevators 3,500 pounds at 250 feet a minute.

Considering the large number of lights, and power necessary to properly equip this wonderful store, one would think that economy would lie in having its own power plant. Nevertheless this is not the case. While space has been reserved for the installation of a 3,000 horse power generating plant, the whole plant is operated from the mains of the Chicago Edison Company. The installation for electric light and power supplied from a central station is probably not surpassed in this country or abroad.

The connecting load in this block of buildings amounts to more than 2,800 horse power in motors and an equivalent in light of over 40,000 16-candle-power lights. Reducing the power and light to 16-candle-power equivalent shows a total connecting load of about 82,000 16-candle-power lights.

There are 35,000 16-candle-power incandescent 115-volt lamps and 500 2,000-candle-power arc lamps at 115 volts, with 2,000 extra outlets for special and local displays. There are 2,000 lamps in the display windows on the street frontage. These are arranged in trough reflectors, and so far as outside observation is concerned no lights are in sight.

One can conceive a fair idea of this immense power and lighting system by mental comparison. Marshall Field & Co.'s combined electric light and elevator plant would furnish lights for a city the size of Toledo, Minneapolis or St. Paul.

To light the various cases throughout the store, watertight iron floor boxes are installed, each box being fitted with a brass cover. About 400 of these boxes are installed, having a total capacity of over 5,000 lights. From these boxes tap circuits are run to light up the cases. Considering that the framework of these cases is but ¾ inch wide, the matter of lighting them, concealing the work, and retaining the line of beauty, called for considerable ingenuity. This was accomplished by the use of small specially constructed troughs placed in the upper front edge of the show case, and protecting them from view by means of mirrors about 2 inches wide. In the troughs are placed special small Edison sockets with miniature lamps.

Ventilation is provided for the enormous room in the basement by a system of blowers, which in reality is a combination ventilating and heating plant. During the warmer months it cools and ventilates, while in the winter months the air is drawn over heated pipes and forced into the room heated, thus serving the purpose of a heating plant.

The water system which supplies the 150,000 gallons of water used in this store daily is located in the basement and is equipped with four pumps, run by electric motors, each of which is equal to 100 gallons a minute.

An indication of the amount of business handled through this busy store is shown by the large private telephone exchange installed in the building. The exchange is a branch of the Chicago Telephone Company's system, and is located on the third floor. The switchboard represents the highest type of private branch-exchange switchboard construction, and has all the details as complete as the latest relay central-office switchboard. It is now equipped for 250 private branch-exchange lines and 40 trunk lines leading to the central exchange. The ultimate capacity of these six operating boards will be 400 lines.

The refrigerating plant is operated by 20 horse power brine pumps and two 75 horse power ammonia compressors, all electrically driven. This system has a capacity of 50 tons of refrigeration a day. Cold water is forced throughout the buildings and to the tea rooms for drinking purposes by two 15 horse power motor-driven pumps.

The pneumatic cash-carrier system is operated by two 75 horse power and two 40 horse power motor-driven blowers. There are now some 200 stations installed, and others will be added as fast as found necessary.

For protection, the entire establishment, excepting the annex, is equipped with automatic sprinklers installed by the General Fire Extinguisher Company, Providence, R. I. The water supplies for the sprinklers comprise two 30,000-gallon gravity tanks, four 4,500-gallon pressure tanks, two 1,000-gallon Eastern Underwriter fire pumps, taking 12-inch suction from a 6,000-gallon surge tank, which has an 8-inch connection from the city main.

The tanks are in two batteries, each comprising one gravity tank and two pressure tanks, with a separate 8-inch tank riser running down to the underground pipe, then to a 12-inch header at the fire pump. Each lead from this header has its own indicator gate for shut-off. The system embraces an aggregate of over 2,000 feet of cast-iron pipe in sizes ranging from 4-inch to 10-inch, and connecting to the several risers in each of the two buildings; also to nine Siamese steamer hose connections.

The installation comprises 15,500 sprinklers and is provided with 23 variable-pressure alarm valves and five Grinnell dry-pipe valves. There is also an electric alarm system of gongs throughout the buildings, and annunciator located in the power plant. At every riser shut-off and drain valves are provided on each floor. The first seven stories of the new building have all the pipes concealed, only the sprinklers and the hand-wheels of the valves being visible below the ceiling.

THE BURNING OF PULVERIZED COAL.

C. O. Bartlett in the Journal of the Association of Engineering Societies, July, 1903, p. 44.

To burn coal in a powdered form successfully, three things are necessary, (1) uniformity of moisture, (2) uniformity in size of grain, and (3) the amount of air required for perfect combustion. In my judgment, it is impossible to get perfect combustion by feeding coal in different states of moisture.

First. Coal varies in moisture from 4 per cent. to 15 per cent. During the summer season, especially, ordinary bituminous coal frequently has not more than 4 per cent. moisture, while during the winter and spring or during the rainy season, and especially when the coal is saturated with water and then frozen, the same kind of coal will contain as high as 15 per cent. moisture, and much of this moisture in the form of ice.

Second. It is impossible to get the best results by burning large pieces of coal together with the dust of the coal. The coal must be reduced to grains of equal size and should be 80 mesh fine.

Third. About 140 cubic feet of air are required to burn a pound of coal. The admission of air cannot be successfully controlled by natural draft. Forced draft must be used.

If the three requisites named are secured, perfect combustion can be had, and perfect combustion means no black smoke, no cinders, and very little ashes, and a saving of practically 40 per cent. in the amount of coal used.

A test was made on a 60 x 18-inch horizontal tubular boiler, of about 125 horse power, as follows: First we would run a day on powdered coal, the next day on slack coal and the next day on run-of-mine coal. We afterwards made a test of longer duration, running 88 hours on powdered coal and 48 hours on the same kind of coal without drying and pulverizing and by hand firing, and the gross saving was found to be about 40 per cent. in the amount of coal used. Six per cent. of moisture was taken out of the coal. When burning the powdered coal, the amount of ash did not exceed 3 per cent., while in the ordinary way of firing it was a little over 19 per cent.

The first matter to consider in balancing the results of such a test is the cost of drying. Our firm recommends the use of the rotary cylinder dryer, using direct heat, and the products of combustion passing on the outside of the cylinder only. In some few cases the products of combustion are first allowed to pass on the outside of the dryer, then to pass through the coal, and when this is done it is safe to estimate on a basis of 10 pounds of moisture evaporated by 1 pound of fuel, but the operation is not a safe one. I think it is safe to estimate the cost of drying the coal on a basis of 8 pounds of evaporation to 1 pound of fuel. Estimating on a basis of $2 per ton for coal and taking the loss in moisture at 5 per cent., the cost of drying and the loss in moisture will be less than 12 cents per ton. This estimate is based on drying not less than 40 tons a day.

Second, the cost of pulverizing. With one good mill, using 25 horse power, 4 tons of coal can be pulverized in an hour. At the present time there are three systems:

The French Buhr or emery wheel system.

The Huntington or centrifugal type.

The ball or tube mill system.

To these I might add the Kent mill which is now being put on the market, and in which the pressure of the rolls against the casing is obtained by means of screw pressure, which adds to the capacity and at the same time admits of great reduction in speed, adding greatly to the life of the mill. At present it is safe to estimate on a cost of ten cents per ton for pulverizing.

Third. The cost of elevators, conveyors, bins, cost of running blower or feeder, interest on investment, and wear and tear should not amount to more than 10 cents per ton, and probably not more than 5 cents per ton, making the total cost of drying, shrinkage, pulverizing, feeding and cost of driving the machinery, interest on investment, etc., in quantities of 40 tons a day, about 32 cents per ton. This shows, on 40 tons of coal a day, coal costing $2 a ton, a net saving of a little less than $20 a day, or 50 cents per ton.

Another important factor, which I have not considered, is the doing away with the fireman, as in the use of this system no fireman is required. The fireman's wages are therefore saved. Also, there is not more than one-third as many ashes, and there are no cinders at all.

To burn pulverized coal economically it must be burned in fairly large quantities; in other words, I do not think it would pay to put in a drying and pulverizing outfit unless the amount of coal used is at least 10 tons per day. In large cities this difficulty can be obviated by having a central drying and grinding plant and selling the pulverized coal to small consumers. In this case it would be necessary simply to put in a feeder, for feeding the coal in a powdered form, and a tank for holding it.

The next obstacle, and one which I consider of very great importance, is the danger arising from storing large quantities of powdered coal. From the best information that I have been able to obtain I do not think it is practical to store large quantities of pulverized coal for any length of time, and this means that it would not be practical to dry and pulverize the coal at the mines and ship it in this form.

The next question, and quite a serious one, is the construction of the arch. In our experiment we used the Rowe system, which consists in blowing the pulverized coal, by means of an ordinary fan or blower, up against an arch over the fire. The arch wall becomes very hot and immediately ignites the coal, and when the proper amount of air is used the combustion is perfect. We find that a 2-ounce pressure is best for this purpose. It will be readily understood that, in order to withstand this excessive heat, the best kind of arch wall is necessary, and that specially constructed brick should be used. While this is really quite a serious question, I do not doubt that it will be satisfactorily answered. Mr. Fred Sieg-heim, of Germany, has an invention for covering the arch wall, by which it can be made to withstand a tremendous heat, up to 3,000 degrees or more, without injury, and to last for a long time; in fact, until the draft of air has worn away this material. As near as I can ascertain, this mixture is composed largely of the dust of carborundum, which is now being manufactured in large quantities at Niagara Falls. In taking the matter up with this company, I find that Mr. Siegheim has contracted for the exclusive output of this dust for five years. I consider this a very important invention and well worthy the most careful consideration of the engineers of the United States. It seems a little humiliating that the Germans should get ahead of us, but such appears to be the case.

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ANECDOTES OF THE FAIR OF '46.

"It has not been sixty years since the sewing machine made its appearance in Washington," said an old timer to a "Star" reporter, "and there are quite a number of not very old people who remember the occasion. During the great mechanics' fair, which was held in 1846, opening May 21 of that year, in a specially constructed frame building in Judiciary Square, it was one of the star exhibits. It was said at the time that one of the main objects of the fair was to influence legislation in Congress on the tariff to show what the American workingman could do, and how little we were dependent on other countries for the necessaries of life.

"I remember that the sewing machine was the greatest attraction of the fair and interested the crowds about it, and there was difficulty experienced in getting near it. As may be supposed, the machine at that period had not been brought to the perfection it reached by subsequent improvement, but it did its work to the amazement of the thousands of visitors, and as a labor-saving machine, together with McCormick's reaper, then first exhibited here, caused much discussion. Among the seamstresses the sewing machine was looked upon as the instrument which would deprive them of a living, and it was predicted that its adoption would drive hundreds to poverty. At that time the price was high, and many hoped that so much would be asked for it as to prevent its general use.

"The effect of its introduction was to some extent discussed in the papers of the day, and I believe in some of the manufacturing cities the working people were much excited over the revolution its adoption was expected to bring. I read an abstract of an address by a pastor in one such city, in which he said to the factory people and seamstresses that they had nothing to fear from its introduction. He said notwithstanding so much more sewing could be done by machine, the tastes of the women were such that should the cost of making a dress or other garment be cheapened, more elaborate garments would become the style and there would follow such a demand that instead of taking work from the sewers there would be more. In other words, while the cost of making a plain dress would be lessened, the additional trimmings, extra plaits, seams, etc., would make up for any loss.

"There was no fear that the labor-saving mower and reaper would have such an effect upon the masses," continued the narrator, "for all recognized that should it be effective the cost of daily bread would be lowered. I should mention that the revolving pistol, patented by Colonel Samuel Colt, some ten years before, was an object of much interest, especially to military men, and the fact that it was then on trial in warfare—the Texas Rangers of Captain Samuel H. Walker, engaged in the Mexican War, being armed with the pistols—imparted an additional interest to the subject.

"There were many other exhibits at the fair mentioned, and the display was a revelation to the masses, a great educational object lesson, and probably the most important exhibits were those named. I should not, however, omit to notice another. As is customary, admission tickets were issued to all exhibitors, and hundreds of our younger people were benefited thereby, these being mostly girls who had specimens of sewing, embroidery.

"There was a boy living in the old Second Ward who got up an elaborate aggregation of cogwheels, levers, shafts, etc., so intricate in looks as to bewilder any but the initiated, whose sole object was to obtain an admission ticket. This he entered, but not for a prize, and called it a 'wing wang.' By winding up the motive power, a clock spring, it went into operation with such a clatter as to drown the noise of the larger machines. Curiosity led to many inquiries as to its use, but the only reply obtained was that it would grind smoke, when forced in the hopper, and cool the air with its revolving flippers. Useless though the machine was at the time, it drew the attention of an influential gentleman to the boy, who made him his protege, and the result of the boy's ingenuity was subsequently seen by an improvement in drawbridges and in the matter of lanterns for lighthouses."—*Washington Star.*

* * *

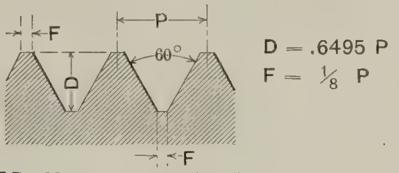
Josef Madersperger, a native of Kufstein in Tyrol, is said to have invented a sewing machine in 1814 which was improved by him in after years so that it was a practical operative mechanism, considering the state of the mechanical arts in that era. But from lack of financial assistance the machine was never manufactured and Madersperger, in common with many early inventive geniuses, never profited by it since history has it that he died a pauper in the workhouse. In after years the worth of his invention was recognized and now the rich sewing machine manufacturers of Vienna, Austria, have unveiled (June 7) a beautiful monument to his memory.

SCREWS.

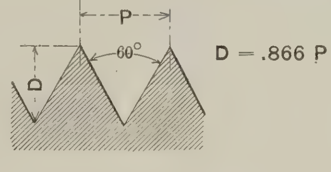
EXTRACT FROM ARTICLE IN THE "MICHIGAN TECHNIC," BY EDWIN H. EHRMAN.

The purpose of this article is to present a series of notes of a practical nature, relating to the several standards of screws, that may be of service to those engaged in machine design or shop management. It is at the outset advisable to review the different forms of screw threads in use, with some note and comment as to their fitness for the various kinds of screws.

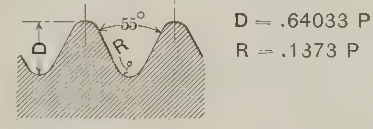
Of the styles of threads in common use in the United States, the United States Standard (also known as the Franklin Institute, or Sellers' form) is the most feasible form to use in the manufacture of screws and bolts. While the thread itself may be a trifle weaker than the sharp V form, it gives a screw that for the same nominal size and pitch is much stronger than the screw with the V form of thread, as the core diameter of a screw with U. S. S. threads is greater by .43 of the pitch than that of a screw with sharp V threads. The increased danger of a screw with U. S. S. form of threads to fail, due to the threads stripping, as compared with that of a screw with sharp V threads, is more apparent than real, as experience has shown that a screw will give way almost invariably by breaking across the diameter at the bottom of the threads before the threads themselves will shear or strip.



UNITED STATES STANDARD



V STANDARD



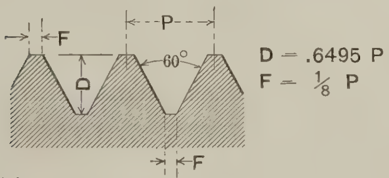
WHITWORTH STANDARD

NUMBER OF THREADS PER INCH.

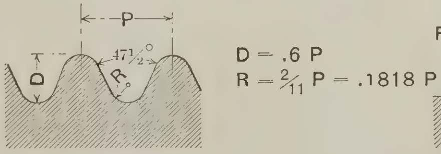
Diameter	¼	5/16	⅜	7/16	½	9/16	⅝	11/16	¾	13/16	⅞	15/16	1	1⅛	1¼	1⅜	1½	1⅝
U. S. Standard	20	18	16	14	13	12	11	..	10	..	9	..	8	7	7	6	6	5½
V	20	18	16	14	12	12	11	11	10	10	9	9	8	7	7	6	6	5
Whitworth	20	18	16	14	12	12	11	11	10	10	9	9	8	7	7	6	6	5

Diameter	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾	2⅞	3	3⅛	3¼	3⅜	3½	3⅝	3¾	3⅞	4
U. S. Standard	5	5	4½	4½	4½	4	4	4	4	3½	3½	3½	3½	3¼	3¼	3¼	3	3	3
V	5	4½	4½	4½	4½	4½	4	4	4	4	3½	3½	3½	3¼	3¼	3¼	3	3	3
Whitworth	5	4½	4½	4½	4	4	4	4	3½	3½	3½	3½	3¼	3¼	3¼	3¼	3	3	3

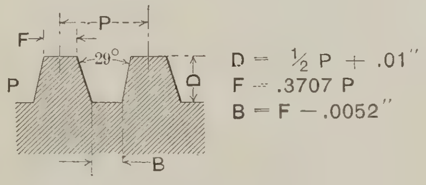
The U. S. S. thread is used on milled screws, finished studs and nuts, especially those entering into the construction of steam engines and other engineering work of large proportions, and the better grades of machine tools and machinery. This form is admirably adapted to rough bolts and studs, and many manufacturers are using it in lieu of the V thread. A sharp V thread die has a tendency to tear the tops of the threads in threading rods or bars that are larger than the finished diameter of the screw; and as bar iron varies considerably in diameter, and is liable to be slightly over size, it has been the custom in cutting threads on it to use dies that are 1-32 inch larger than the nominal size, so that the die will not cut down the diameter of the bar, with the attendant liability of making a poor thread as well as unnecessarily overworking the die. Occasionally the writer has noticed that rough bolts and studs have been threaded even size when the diameter of the bolt was small enough to admit of so doing. This leads to confusion, especially in those sizes where more than one standard of pitch is in use. For instance, in purchasing ½-inch machine bolts one might get ½ inch over size or even size with 12 threads, or ½ inch over size or even size with 13 threads, or ½ inch, 13 threads U. S. S. The adoption of the U. S. S. form of thread would entirely obviate the present difficulty.



INTERNATIONAL STANDARD



BRITISH ASSOCIATION STANDARD



ACME STANDARD

BRITISH ASSOCIATION STANDARD THREAD.

Number	0	1	2	3	4	5	6	7	8	9	10	12	14	19
Diameter, m.m.	6.0	5.3	4.7	4.1	3.64	3.2	2.8	2.5	2.2	1.9	1.7	1.3	1.0	.79
Pitch, m.m.	1.00	0.90	0.81	0.73	0.66	0.59	0.53	0.48	0.43	0.39	0.35	0.28	0.23	0.19

INTERNATIONAL STANDARD THREAD.

Diameter, m.m.	6	7	8	9	10	11	12	14	16	18	20	22	24	27	30
Pitch, m.m.	1.0	1.0	1.25	1.25	1.5	1.5	1.75	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.5

Diameter, m.m.	33	36	39	42	45	48	52	56	60	64	68	72	76	80
Pitch, m.m.	3.5	4.0	4.0	4.5	4.5	5.0	5.0	5.5	5.5	6.0	6.0	6.5	6.5	7.0

In the manufacture of nuts there is the same tendency in threading for the threads to tear if made perfectly sharp, and also a greater liability of the tap breaking from overwork and clogging; consequently, it has become the custom to ream the nut blanks large enough to leave the thread flat, quite as much so as in the U. S. S. form. A valuable point to the manufacturer, both in the making of nuts and in the machine shop, is the greater strength of taps having the U. S. S. form of thread as compared with those having V threads, which means a double economy, due to the longer life of the tap and the greater duty of which it is capable. A good feature of the U. S. S. thread, and one that will bear extending, especially in the smaller sizes, is that it tends toward a finer pitch than the V and Whitworth standards, notably in the ½, 1⅞, 2¼, 2¾, and 5-inch sizes, and it might have been well when the system was planned if the threads per inch for ¼ inch in diameter had been made 22 instead of 20; for 5-16 diameter, 20 instead of 18; and for 1⅛ diameter 8 instead of 7. At present some of our foremost manufacturers of machinery are using ¼ and 5-16 inch screws with the finer threads above noted, styling them the U. S. F. (form) instead of U. S. S.

The sharp V thread will long continue in general use, due primarily to its simple form and secondarily to its having so thoroughly established itself in mechanical industries. It has another very strong claim, however, in the fact that it is admirably adapted to the making of steam-tight joints. Both in boiler bolts, patch bolts, and in iron pipes and fittings it answers the purpose better than any other practical form of thread.

There is no variation at the top and bottom of the thread, as there may be in both the U. S. S. and Whitworth forms of thread, with the resulting liability of leakage through the clearance thus formed. Sharp V threads are used on machine screws, on rough bolts, on boiler bolts, and other bolts where a steam-tight fit is needed, and largely on milled screws.

The square form of thread is usually made about twice as coarse in pitch as the V or U. S. S. threads, and partly for this reason and partly because the perpendicular walls of the thread do not allow the chips to free, it is a troublesome thread to cut with taps and dies. There is also difficulty where more than one cut is made to produce the finished screw, due to the succeeding taps or dies not registering with the partly cut thread, and consequently cutting away the thread already formed. This form of thread is largely used on adjusting and power conveying screws.

The Acme screw thread was designed to overcome the objectionable features of the square thread. It has many good points, not the least of which is its strength and the ease with which it may be cut, compared with the square thread. This is due to the greater strength of the teeth in both taps and dies, as well as to the facility with which the cuttings free themselves. This thread is advocated as a substitute for, and in preference to, the square form of thread.

The Whitworth form of thread has two points of merit that commend it highly where heavy service is required. First, screws with this form of thread have all of the strength possessed by screws with U. S. S. threads, with the advantage over the latter of having no sharp edges or corners from which fractures may start. Second, screws and nuts with this form of thread will work well together after continued heavy service where the other forms of thread would fail. Whitworth threads are used (in the United States) chiefly on special screws, such as screws for gasoline needle valves where a liquid-tight and yet working fit is desired, also on some makes of ordnance breech blocks.

The standard thread in the International System (*Systeme International*), adopted by the International Congress for the unifying of machine screw threads, held at Zurich in October, 1898, resembles our own U. S. S. thread. The formulas are the same but the pitches are somewhat finer, a distinct advantage, especially in the finer sizes. To provide for a thread with a clearance at the bottom such as is in general use in France, the Congress specified that "the clearance at the bottom of the thread shall not exceed 1-16 part of the height of the original triangle. The shape of the bottom of the thread resulting from said clearance is left to the manufacturers. However, the Congress recommends rounded profile for said bottom." By this wise provision, choice is given manufacturers in the several countries interested to make the bottoms of their threads flat or rounded, as desired, and yet have them conform to a common standard so as to interchange, if necessary.

The S. I. thread has been adopted by the Swiss Union of Manufacturers, the German Association of Engineers and the Society for the Encouragement of National Industries.

The British Association Standard Thread is patterned after the Whitworth, though more acute and shallow, and with larger rounds at top and bottom. The dimensions of screws with the thread are given in mm., the largest being 6mm. in diameter, which is the smallest size of the International system. It corresponds to our system of machine screw sizes smaller than ¼ inch in diameter.

Attention has been drawn to the matter of pitch in the foregoing paragraphs in comparing the several systems of threads, and comment made on the desirability of using finer threads. The pitches of the U. S. S. thread are no doubt suited to bolts used in the larger work in mechanical and civil engineering, but perhaps not quite so well adapted to the screws used in smaller work—especially the sizes of screws below one inch, and there has been a tendency among manufacturers to use screws one, two and even four threads finer than standard. This leads to much annoyance and possibly to confusion, but it suggested a scheme that the writer has adhered to for some years. The plan has been that where a deviation from standard is deemed desirable, the pitch used is one of a range of pitches, the units of which are suited to the different materials and purposes. Out of this scheme, intended to cover the use of screws and nuts only, has developed the system of making all special taps—even to 6 inches in diameter—with one of the following pitches: A pitch of 8 threads is used for screw threads on large pieces and on smaller work where the material is cast iron. A pitch of 12 threads is used where a finer thread is needed and where the material, in part, is brass. This pitch is that commonly used on boiler bolts, planer head bolts, and to a large extent in the nuts fitting on milling machine cutter arbors. A pitch of 16 threads is used where a still finer pitch is wished, and is adapted to adjusting rings, collars and nuts on shafts and spindles used in machinery—especially on hollow spindles used on lathes, drill presses and screw machinery. Other pitches for smaller screws, each pitch covering several diameters, have been established. This has been done largely to enable quick repairs of special cutter heads and holders. The following list explains itself, additional sizes of taps being added as occasion requires:

Machine screw sizes—Nos. 6, 8, 10, 12, and 14, all 32 threads, 7-32, ¼; 9-32, 5-16, 11-32, ⅜, all 24 threads; ¼ to ½ all 20 threads; with isolated sizes of one or another of the above pitches up to 1 inch and 1¼ inches in diameter. The foregoing may be quite unpractical in some shops, but on the other hand the carrying out of some systematic plan in establishing special sizes of screw threads would undoubtedly add to the economy of the tool-room and the machine shop.

Passing from the shop into the drafting room, one finds many ways and means of making and keeping lists of the screws used in the shop for special purposes. In one office will be found large sheets of drawings of screws burdened with a network of dimensions and lines. In another a tabulated sheet is used for each style of screw employed; a drawing of the screw with lettered dimensions above, and below it the table of dimensions with the proper index letter at the top of each column. In still another office will be found descriptive lists of the screws, bolts and nuts used in each machine or article manufactured, with reference numbers indicating the number of the piece or drawing from which each item is taken. Ofttimes a board of mounted samples takes the place of drawing or list. Each system, no doubt, answers the requirements of the office using it, otherwise it would be replaced by a better one; each has its good points, too—from the completeness of the first system to the simplicity of the last.

For special screws and formed pieces that are quite different from stock goods, a drawing of each piece is probably the only way of fully describing it, but for the average screw, resembling in some degree the stock patterns, the most compact record is by tabulated dimensions, referring to a diagram of a typical screw of its class. As one purpose of these records is to facilitate the ordering of screws, it follows that the specifications, drawings, and description should be explicit and entirely free from ambiguities. Many curious screw sheets and blueprints come under the writer's notice, and they lead one to think that either too little thought or too much time and paper has been spent in making them, and they prompt a few comments and general suggestions.

In general—Screws that enter a tapped hole have their lengths measured to the extreme points. (See *L*, Fig. 1, and *X*, Fig. 3.) Screws that enter a nut (i. e., bolts and studs), have their lengths measured to the end of the thread, leaving the oval additional. (See *L*, Figs. 2, 3 and 4.) Measurements of length are made from the outer diameter of the under side of the head. (See *L*, Figs. 1 and 2.) The diameter of a square or hexagon head is understood to mean the short diameter. The blank part of a screw body is understood to extend to the first marks of the thread, and should measure in cap screws as shown in Fig. 1. (See *B*, Figs. 1, 2 and 3.) The length of the thread is understood to apply to the useful part of it. (See *T* and *N*, Figs. 1, 2 and 3.) Note that the lengths *N* in Figs. 2 and 3 should not include the partly formed thread made by the leads of the die, as a nut would bind if forced over them. This is true also of cap screws, as shown in Fig. 1. The length of the thread on the tapped end of a stud, however, includes the "lead" or partly formed thread, as the stud when screwed tightly into a tapped hole will enter it practically the whole length of the thread. (See *T*, Fig. 3.)

Ordinarily.—The length of the blank (*B*, Fig. 1) part of the body of a cap screw (except for very long screws) is ¼ *L*. The length of thread (*N*, Fig. 2) on coupling bolts, is 1½ times the thickness of the nut, where only one nut is used. The partially formed threads made by the leads of the die is, on most screws, about three threads in length; on set-screws and tap ends of studs about two threads in length. The angle *A* (Fig. 1) in cap and machine screws is 40 degrees. The angle *A* in boiler patch bolts is 45 degrees. The short diameter of hexagon nuts, both finished and semi-finished, and rough square nuts is equal to $1\frac{1}{2}B + \frac{1}{8}$ inch where $B =$ size of bolt. This is true also of coupling bolt heads (hexagon) which are not finished on their sides. (According to the Franklin Institute Standard this would apply only to unfinished heads and nuts. The diameter of finished heads and nuts would be 1½ *B* + 1-16 inch). The regular thickness of finished and unfinished hexagon nuts and unfinished square nuts is equal to the diameter of the bolt. This is true also of the heads of coupling bolts.

According to the Franklin Institute Standard, the above would be true only of unfinished hexagon heads and nuts. The thickness of finished hexagon nuts and heads would be *B* — 1-16 inch. Square heads are not supposed to be finished and their thickness is one-half the short diameter or ¾ *B* + 1-16 inch. The thickness of check and jamb nuts is ½ *B* + 1-16 inch, where *B* is less than 1¼ inch, and ½ *B* + ⅛ inch where *B* is equal to, or greater than, 1¼ inch. The diameter is the same as that of unfinished nuts. The length of head for milled screws equals the diameter of the screw. The dimensions of a screw should be expressed in terms of the diameter × the length (diameter first).

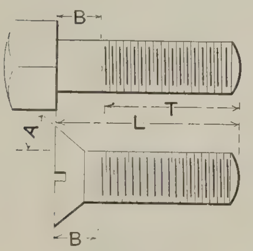


FIG. 1

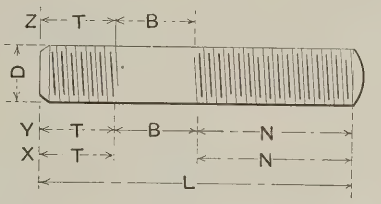


FIG. 3

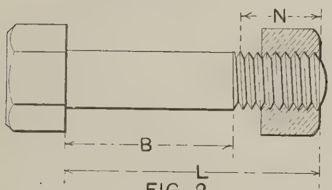


FIG. 2

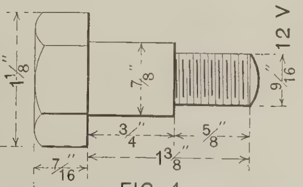


FIG. 4

Industrial Press N.Y.

The fact that the proportions of nuts and screw heads are governed largely by formulas has led the writer to formulate rules that govern those parts of machinery in which screws and nuts are used. Among the parts that may be standardized are: Finished washers suited to cap screws and to nuts; bosses on castings for setscrews; lugs on castings suited to roundhead screws, to square and hexagonal head screws, and to nuts or bolts; thickness of collars of collar screws; sizes of taper pins relative to the diameters of the shafts in which they are used, etc. Diagrams standardizing parts and pieces such as those enumerated save much time in the drafting room and relieve the draftsman of a large part of the detail that otherwise must be worked out anew in each recurring case.

Returning to the subject proper, it might be of profit to inquire into the ways of expressing by drawing, diagram or words the dimensions of screws and bolts. It is quite a common practice to overload a sketch or diagram with dimensions, and it is also of frequent occurrence that dimensions are given which are complements of the ones intended. This may be made clearer by an illustration or two. A sketch such as Figs. 1 or 2, with the dimensions *L* and *B*, indicates that the piece is wanted with the blank part of the body a specified length, whereas this is very unusual; and if the piece was made as called for, the working useful part of the thread would probably be too short. What is usually intended to be expressed are the dimensions *T* and *L*, or *N* and *L*. A sketch such as Fig. 3, with the length expressed as shown at *Y*, leads to confusion, as it is impossible to leave as much blank as the dimension *B* calls for if the lengths of useful thread are as called for by the dimensions *T* and *N*. Ordinarily what is desired is the length of the threads *T* and *N*, as shown at *X*, which, with the dimension *L*, is enough. If the blank part is to be of a specified length, the dimension should be written as shown at *Z*, stating also the length *L*.

At this point it might be well to state that a stud with one end chamfered is usually threaded large enough on that end to fit tightly in a tapped hole; and if it is desired that both ends are to be threaded to fit nuts, then both ends are made rounding and the lengths of thread for both ends are expressed as shown at *N*. Other points are brought out by Fig. 4. Though apparently very clear and exact, it does not mean just what it states. In the first place, the dimension 1⅛ inch should be explained by words under it such as "short diam.," as the intention is no doubt that the head is desired 1⅛ inch hexagon, and not 1⅛ inch across the corners. It is conventional to show three faces of a hexagon head, as the other view showing but two faces might be mistaken as showing a square head; while a square shown by a view of one only might easily be taken to represent a round head. The words "short diam." would remove all doubt, while the view shows the style of head. In the second place the drawing shows the thread running abruptly into the shoulder, a practical impossibility, and the dimensions would also lead one to think the nut should screw close to the shoulder. While the thread can be cut with a die of extremely short lead so that a nut could be screwed up to the shoulder, it would be difficult to make a very satisfactory job of it. To avoid any ambiguity it would have been better to have shown a neck in the screw under the shoulder, if the nut is to screw direct against it, or a short blank left under the shoulder if a washer is to be used under the nut.

Another matter not yet touched on, and one that pertains, or should pertain, to all specifications for screws (or other turned machine parts) is that of "fit." Some instruction such as tight, steam-tight, loose, snug, journal fit, tight wrench fit, finger fit, driving fit, etc., is necessary to make a specification complete. No two persons, of course, can or will interpret instructions such as the above in the same way, but the personal element is not so uncertain but that much good would result if the draftsman would give some attention to this matter in making up his sketches or lists. From trade experience, and from machine shop experience as well, it can be said that by being explicit in stating how the several parts of a machine (including screws and bolts) are to fit one another much trouble, time and money can be and is saved; perhaps more than can be saved in other ways requiring the same amount of thought and care.

Turning our attention again to Fig. 4, it is seen that changed as suggested, it clearly shows what is wanted, and, if put into words, the description would read:

Hexagon head shoulder screw.
Head 1⅛ inch hex. × 7-16 inch, nut finish on top.
Shoulder ⅞ × ¾ inch, journal fit in reamed hole.
Body 9-16 inch, 12 V threads, × ⅝-inch, oval additional, light wrench fit in C. H. nut. Necked under shoulder.

Other ambiguous statements are often made in specifications, more frequently in written descriptions, however, than in drawings. A little thought used at the right time will enable one to avoid them in either case. Attention is called to two common errors: (1) That of specifying "standard" without stating which standard, U. S. S. or V, is meant; and (2) that of not properly stating the angle of the head of a screw, such as the lower one in Fig. 1, or of the point of a conical pointed screw. To say the angle is 30, 40 or 60 degrees is indefinite unless qualified so as to plainly indicate whether the angle with the axis of the screw is meant, as shown at *A*, Fig. 1, or the included angle which equals 2*A*. For instance "30 degree point" and "60 degree point" are usually taken to mean the same thing, although in interpreting these phrases one is assuming to mean the angle made by the sides of the point with the axis and the other the angle included by the sides of the point. Though 30 degrees (included angle) and 60 degrees with the axis (or 120 degrees included angle) are both uncommon, nevertheless a mistake is possible in assuming to interpret them either way.

* * *

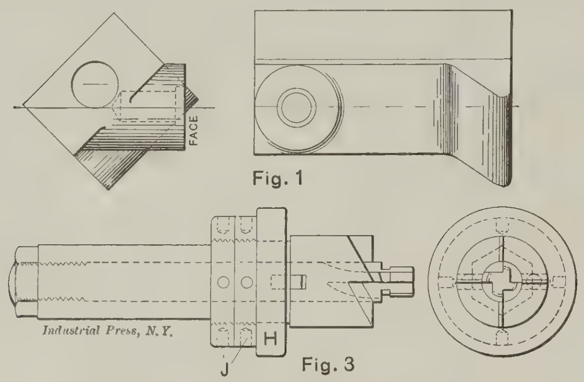
It would be theoretically possible to arrange a compressed-air motor so that it would drive the compressor that supplied it with air for its operation, and still have a surplus of power that could be used for other purposes. This could be accomplished by heating the air before it reached the motor, thus increasing the volume of the air and its capacity for doing work. The apparatus would then become a heat engine similar in principle to the Rider or Ericsson engines, power being derived from the fuel used in heating the air.

LETTERS UPON PRACTICAL SUBJECTS.

A DRILL JIG AND COUNTERBORE.

Editor Machinery:

The design of the jig and counterbore for machining the piece shown in Fig. 1 entailed not a little difficulty, and the tools with which it was finally accomplished may be of interest to anyone engaged in jig work. The casting to be drilled had one hole through its entire length while a second hole, which was afterward tapped, was drilled at an angle of 45 degrees to the side of the casting and with its center tangent to the diameter of the first hole. This hole was counterbored body size for a short depth and the boss in which it was located was faced to an exact distance from the first hole.



Piece to be Counterbored and the Counterbore.

The jig in which the piece was held is shown in Fig. 2. For drilling the long hole the drill was guided by the bushing *A*, while the jig rested upon the legs *BB*. The work was held against a stop *C* by means of a knurled head screw *D* that was carried in a swinging arm *E* which fastened to the body of the jig and received the thrust of the drill. The body of the piece was fastened by means of a clamp *F* into a V-block formed in the jig casting. For drilling the second hole the slip bushing *G* was employed to guide the drill. This was then removed and the combination counterbore and facing tool, shown in Fig. 3, was run into the drilled hole until the loose collar *H* brought up against the face of the tight bushing *I*.

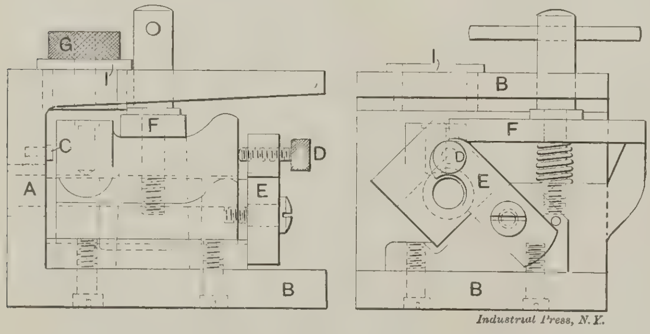


Fig. 2. Jig for Holding Piece shown in Fig. 1.

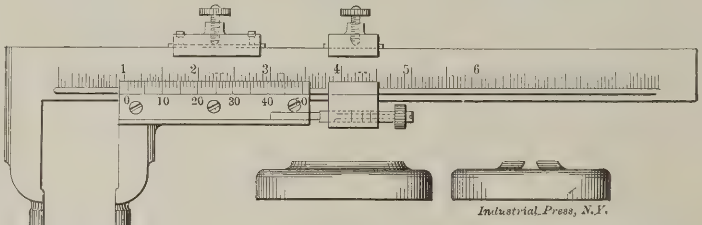
In this counterbore provision was made, by means of the lock nuts, *JJ*, for readjusting the depth of the cut after grinding the facing tool, and the body size of the counterbore had an independent adjustment which was locked by the nut at the upper end of the holder. After this operation the hole was tapped while still held in the jig, thus insuring that the tapping would be perfectly true with the face of the hole.

S. J. P.

A SPECIAL DESIGN OF SIX-INCH VERNIER.

Editor Machinery:

The accompanying sketch illustrates a 6-inch vernier, of the writer's design, which has several points of advantage over the usual form of vernier caliper and is suitable for use both as an outside and an inside caliper gage. The graduations on the beam and vernier plate are open to reading and no part of them is obstructed to view by the cross bar of the sliding head, as is the case in some calipers of this class. The reading on the bar gives the value for outside measurements, i. e ,.those made on the inside of the jaws; while the same size on the outside of the jaws is provided for, in the adjusting or follower head, by simply slackening the binding screw on the caliper head and moving it until it comes to a stop. To illustrate: the gage as shown is set to 1 inch outside diameter and if we desire to bore out a hole for the same exact size, or any amount under or over, as for drive or running fit, we first loosen the binding screw on the follower head and move it to the left until it comes to a stop against the caliper head, in which position we clamp it securely. Next loosen the binding screw on the caliper head and move it to the left until it is stopped by the interference of the knurled screw head against the follower. We then have the same size on the outside points that was indicated for the inside. Provision is made for adjustment when correction is necessary. This duplication, in the hands of an expert, equals that of any standard inside and outside gages and has the additional advantage that any fractional measurement, in thousandths, is obtained over or under standard size.



Six-inch Vernier of Special Design.

This vernier may be used as a height gage by inserting the base in the dovetailed block shown in the cut, as the height of the block is such that it is 1 inch from the base of the block to the face of the caliper jaw. A scribing point may be clamped on the vernier head and lines scribed to exact height in thousandths. The groove at the base of the lines on the beam is for the purpose of cutting the graduations, as cutting out a chip disturbs the normal length of the bar less than the ordinary way of marking the lines.

F. W. Clough.

TOOLS FOR MOLDING PORCELAIN.

Editor Machinery:

While there may be nothing novel or strange in the construction of the mold here described, yet the method and tools by which porcelain is molded may be new to many of the readers of Machinery. A surprising feature of this work is the allowance that must be given for the shrinkage of porcelain, it being no less than 9-64 inch per inch, and one company engaged in the manufacture of porcelain goods, recommends an allowance of 5-32 inch to each inch of measurement. In the mold here described some of the center distances required to be quite accurate and the writer found it most convenient to work to decimals and so used 1.14 as a constant for all of the measurements. Thus the center distance between the holes *AA*, Fig. 1, is to be $2\frac{3}{8}$ inches and in the mold was made $1.14 \times 2.375 = 2.707$ inches.

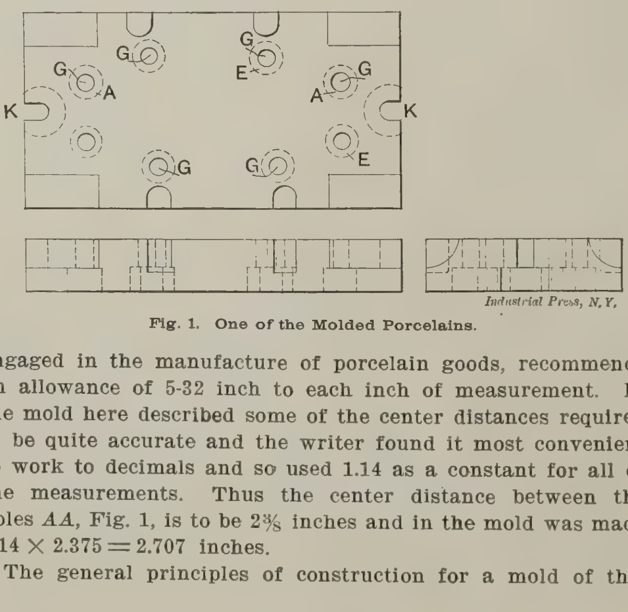


Fig. 1. One of the Molded Porcelains.

The general principles of construction for a mold of this kind will be seen by reference to Fig. 2, which is a detail of the mold used for making the piece shown in Fig. 1. The materials from which these molds are made are cast iron and steel. The molds wear away quite rapidly as the clay has an action like that of pumice stone against the wearing parts. The making of such molds requires considerable care and where sharp corners are needed the fits should be as good as can be obtained. Some draft is required where the bosses for making holes are long, but this will never be very great. The molds are fitted to presses and some pressure is required but not very much and this fact simplifies somewhat the problems of construction.

The views in Fig 2 show the mold with the top block *B* removed. It will be seen that it is essentially a rectangular cast iron box with the bottom held away from the sides by means of collars which are slipped over the screws that hold the bottom to the sides. *C* is the stripper which is made to move up and down in the mold but must be a good fit if a clean porcelain is desired. The bushings *DD* are driven firmly into the stripper and their projecting heads or bosses form the recesses shown in the porcelain at *EE*, Fig. 1. Sliding freely through these bushings, and riveted to the bottom of the mold, are various wire rods of suitable size to make the holes marked *GG*. The stripper rods *HH* slide freely through the bottom of the mold and are of such a length that when the nuts on the strap *I* touch the bottom, the top of the stripper will be slightly above the top of the mold. The pieces *JJ* are inserted in the ends of the mold and form the slots *KK* in the porcelain.

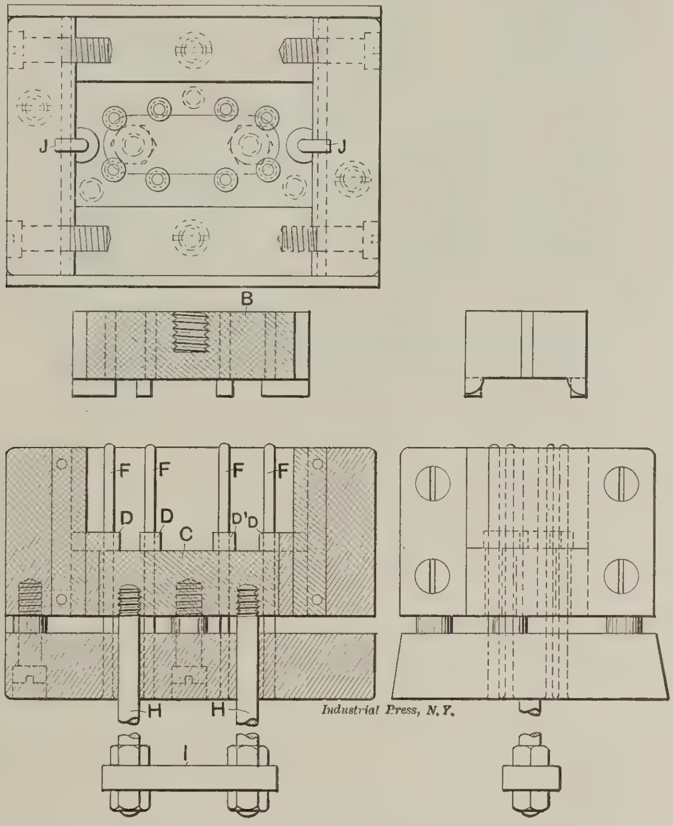


Fig. 2. Mold for Forming Porcelain.

The block *B* is made to fit snugly into the mold and has holes which receive the rods *FF*. There are various projections on it which make the corresponding depressions in the porcelain. The thickness of the porcelain is determined by the distance to which the block is pushed into the mold.

J. R. Gordon.

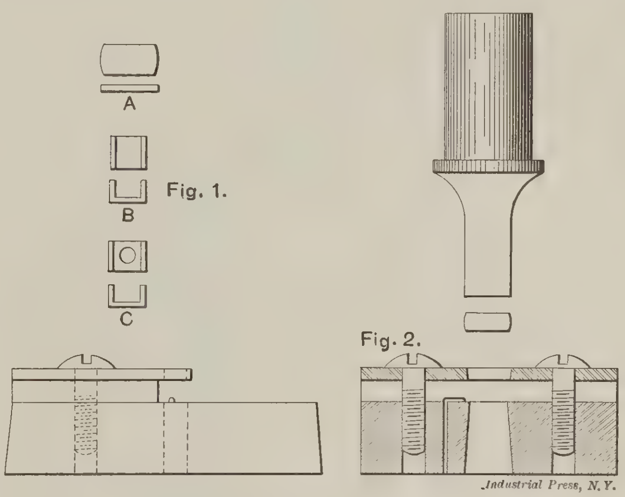
A JEWELRY PUNCH AND DIE JOB.

Editor Machinery:

Fig. 1 represents a piece of punch work that was made from gold stock and which required great accuracy in shaping as well as being bent at a very sharp corner as shown at *B*. Three operations were performed upon the piece as follows: First, cutting the blank as shown at *A*; second, bending as at *B*; and finally, punching the small hole in the bottom as at *C*. The metal was .020 inch thick and was lapped after being soldered onto a piece of jewelry. Several methods of bending were at first tried, but they proved unsatisfactory as too much trimming was required to obtain the necessary finish. The problem of bending was solved satisfactorily by the use of the punch and die here described.

The work was produced by the operations in the order above mentioned, but in order to obtain the proper size of the blank, the bending die was made first. This is shown in Fig. 3 and, as will be seen, is very simple in construction. The die proper, *D*, was planed on its face to receive the gage plates *E E*. A slot *F* was also planed to facilitate sliding in of the blanks, and another slot, running at right angles with *F*, served in conjunction with the tongues of *E E* to locate the blank in position for bending.

In order to obtain the square hole, which was of the exact outside dimensions of the blank, a hob punch was made in the milling machine and the opening broached through the die, starting from the back. In broaching a hole of this nature care must be taken not to remove too much metal, otherwise the surface will be rough and the corners not well defined. As the broach approaches the front of the die the amount of metal removed should decrease until the corners only are touched. After broaching, the die should be highly polished with a lapping stick and hardened, drawing the temper but slightly. It is then again polished brightly with a brass stick and flour of emery. In the opening was fitted the plunger *G* which served as a seat for the work while being formed, as well as acting as a plunger to release the piece when it was completed. This plunger rested on the knock-out *H* which was actuated by the coiled spring, upon which it rested. *I* represents the cast iron bed plate into which the brass casing for the knock-out was screwed. The forming punch was twice the thickness of the stock, narrower than the opening one way and of the same size the other way. With this punch and die we were able to bend the metal to a very sharp corner.



The Blanking Punch and Die.

By the cut-and-try method, in connection with the bending die, it was a simple matter to determine the proper length of the blank, and the blanking punch and die were then made. The punch was simply turned down and milled to the proper width and with this the die was broached. The writer has always found it to be good practice to make the punch first in all cases where it can be machined and then with it broach out the die; this method of procedure invariably resulting in a saving of time. The blanking punch and die are shown in Fig. 2 and will be understood without further explanation.

The perforating die by which the last operation was performed is illustrated in Fig. 4. A stripper plate *K* was fastened onto the base of the die *J*, by screws and dowel pins, and had a projecting arm *L* through which a hole, the size of the perforating punch, was drilled in line with a corresponding hole in the center of the hardened steel die. The indexing dial was made of steel about 3-32 inch in thickness. The top and bottom were accurately faced and the edge knurled to facilitate turning. The stud *M* was inserted in place with a thickness of paper under the head so that it would bind the disk tightly to the surface of the die. The die was then placed on the milling machine and the slot for the lever *N* was milled in the disk, using the slot in the hardened die as a guide. The die was then turned one-quarter of a revolution and the next slot milled in the disk; and so on until all of the four had been cut, using the same cutter that was employed for making the original slot in the die. The index lever *N* is forged from a piece of tool steel and fits snugly the slot in the die, while the part engaging the disk, projects somewhat over the surface of the disk and tapers slightly to take up any possible wear. The lever is pivoted upon the pin *O* which ends about halfway through the hole *P*, thus facilitating its removal should it be necessary. The most particular feature of this die was the location of the four holes, *R*, *R*, *R*, *R*, which served to hold the pieces while they were being perforated. Great care was observed to have the edges of the slots free from burrs, and the index lever was hardened before the holes were drilled. After the lever had been pressed into one of the slots, a hole corresponding in size to the perforation in the die was drilled through the disk from the back side. The disk was then turned to the next slot and so on, the four holes each being drilled while held in correct position relative to its respective slot. After drilling they were enlarged, by counterboring or by the use of several drills, to such a size that the punching might be slipped in without effort yet without leaving any play. The upper side should be slightly countersunk so that the pieces will locate themselves easily. The punch used with this die was of the usual form and is, therefore, not shown.

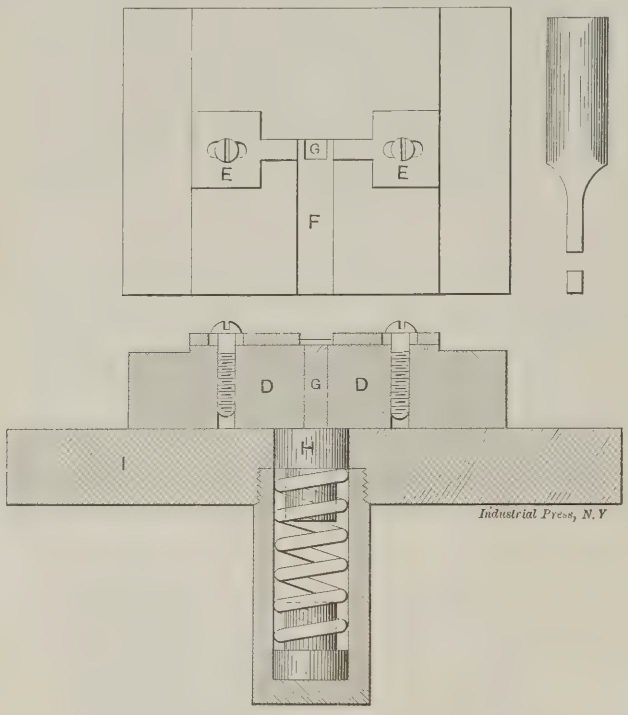


Fig. 3. The Bending Punch and Die.

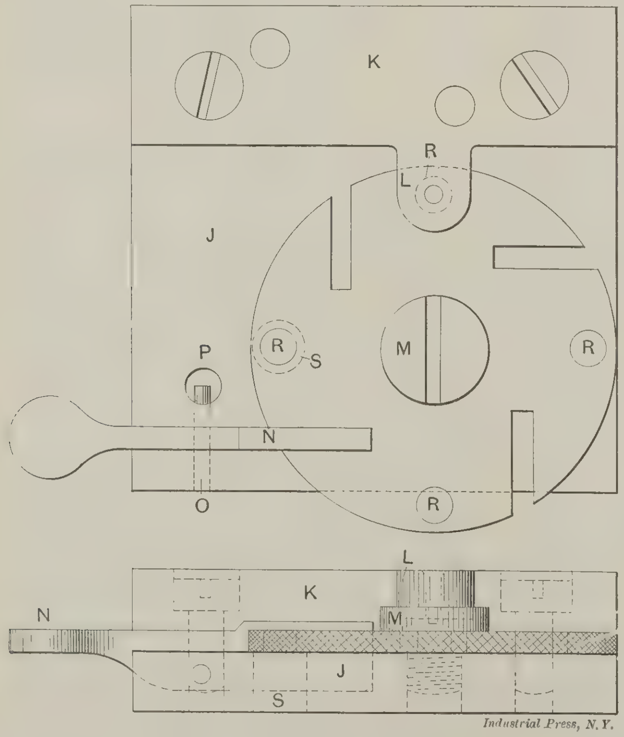


Fig. 4. Magazine for Die Piercing.

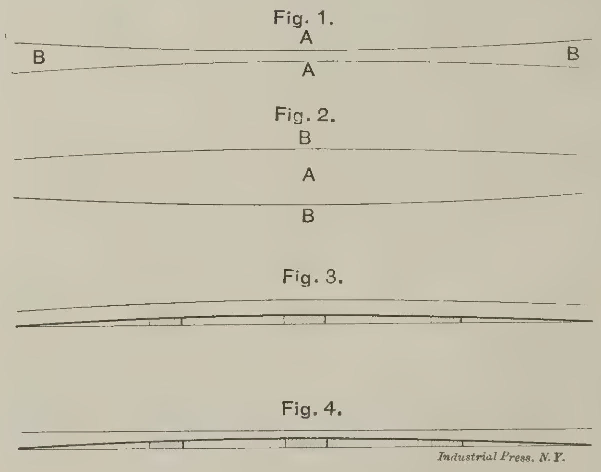
In operation, a punching was placed in one of the holes *R* and the disk moved around by hand until it was opposite and below the hole in the stripper plate. The left hand then allowed the index lever *N* to engage the respective slot in the disk, and the foot of the operator brought down the ram of the press, thus perforating the punching. Another punching was then placed in the hole next to that in use, the index lever disengaged, and the disk moved around a quarter of a turn so as to bring the new punching under the perforating punch. In doing this the punching that had been perforated remained in the disk and was moved around until it came over the hole *S*, in the die; then, as the punch descended, a pin fastened in the holder pushed it through the die and it fell into a box below. It will be seen that this arrangement saves a great deal of time, as it is unnecessary to take the punching from the die and it permits the operator to employ any lost time in placing punchings in the front part of the disk while those under the punch are being perforated.

New York City. FRANK GREINER.

PLANING CURVED SURFACES.

Editor MACHINERY:

By this title is meant the planing, not the milling of curved surfaces that are not circular in contour, the forming of which is known as radial planing. The matter in hand pertains to the formation of long thin pieces with perfectly smooth surfaces, convex or concave in the direction of their length on an ordinary, movable bed, planing machine, and without any special tools or attachments.



Planing Concave and Convex Surfaces.

Suppose that the average connecting rod and coupling rod for locomotives has too little vertical stiffness, especially at high speeds, and too little sidewise flexibility. As, since the days of Matthew Baldwin and his "spherical crank pin" (which really was "barreled" in a spherical curve, to enable locomotives to turn a corner with grace and facility) about the only way of giving a main rod or a side rod any leeway laterally is to give the pin "shake" in the brasses; the laterally flexible rod may be one way out of the difficulty under which all roads labor—and which I may add used to be a specialty of the Baltimore & Ohio Ry. between Baltimore and Washington.

Not that lateral flexibility is the main desideratum, but vertical stiffness is, and that can only be got by widening, or thickening the rod. But even "fish bellying" the rod adds some to the weight, if the rod is of even thickness, and it is desirable to avoid that and even further lighten the rod.

Where the rod is parallel in width (i. e., not fish bellied) a good way is to mill or forge out the center so as to leave the piece of I-cross section.

As the metal along and near the neutral axis is of little or no use in giving vertical stiffness (although it is as good as any as regards laterally stiffening the beam-like member) this I-section is a capital good thing and would be very much better if forged instead of milled; but we have not got that far yet. To mill out all but a flange on each edge and leave a fish-bellied portion of less thickness than the rest (that is, to have an I-cross section of varying height and uniform thicknesses) is not yet a milling nor a planing possibility; and the flanges give lateral stiffness. Now if we will make the top view of the rod as in Fig. 1 and the side view as in Fig. 2, and ease off gradually between the stub ends of the rod proper, we will have an ideal rod.

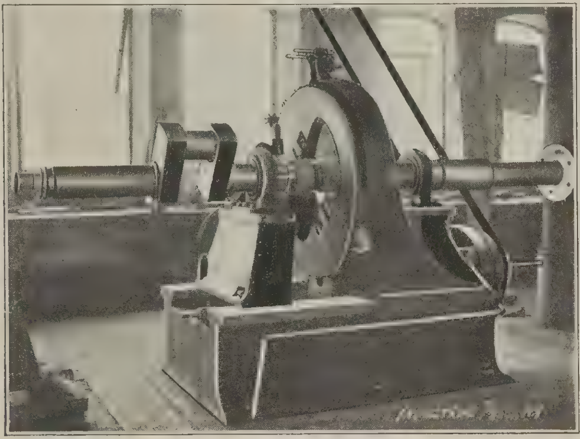


Fig. 1. Crankpin Turning Machine, Front View.

The faces *A A* may be planed or milled, for that matter, on a slab miller. The piece is strapped down at the ends and blocked up in the center, so that it comes to the bed as shown in Fig. 3. Then a planer cut is taken off the convex face, and the piece reversed so as to give another convex face, only the blocking must be higher than for the first operation. When through, the piece has two faces which are concave in the direction of their greatest length. The sketches are purposely exaggerated and simplified. To plane such a piece, thinner at the ends than in the center, strap it down in the center and block it up at the ends. Robert Grimshaw.

Hanover, Germany.

NEW CRANKPIN TURNING MACHINE.

Editor Machinery:

The photographs, Figs. 1 and 2, show a new crankpin turning machine which has recently been erected at the engine works of Messrs. Richard Pohle & Co., Ltd., Riga, Russia. It has been placed on the market by Emil Capitaine, Frankfort-on-Main, Germany, and was exhibited at the Dusseldorf Exhibition last year.

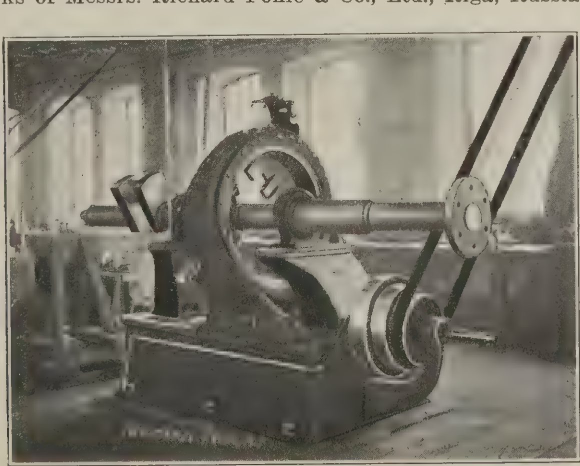


Fig. 2. Crankpin Turning Machine, Rear View.

It is well known that most crankpins are not cylindrical when turned in the usual manner in a common lathe, especially when the crankshafts are of large dimensions. Lately it was necessary to turn a number of crankshafts for some 350 horse power engines for the electric station at Vladuvistok, Siberia, and one of these machines was designed for the purpose, being capable of turning cranks up to 10 inches in diameter and 24-inch stroke. It consists of a bed in box form planed on the upper side, upon which are two brackets fitted with adjustable bearings and vernier scales. The first bracket has also a setscrew attachment for adjusting the crank arm. Between the brackets is the head frame which can be moved longitudinally along the bed. A ring revolves in the head and on the periphery of the ring is cut a 180-tooth gear. This ring is also connected with a disk made in two halves, each having guides, feedscrew attachment and one tool holder. Each half can be moved independently for turning the insides of the cranks. While turning the crankpin itself the whole head frame with ring and disk is moved automatically along the bed. The machine is belt-driven, having a three-cone pulley mounted on the head shaft, which can slide longitudinally in the axle boxes. Six different speeds are provided for, three by running with belt direct, and three by using the intermediate gears. A. Wind.

Riga, Russia.

FACE MILLING.

Editor Machinery:

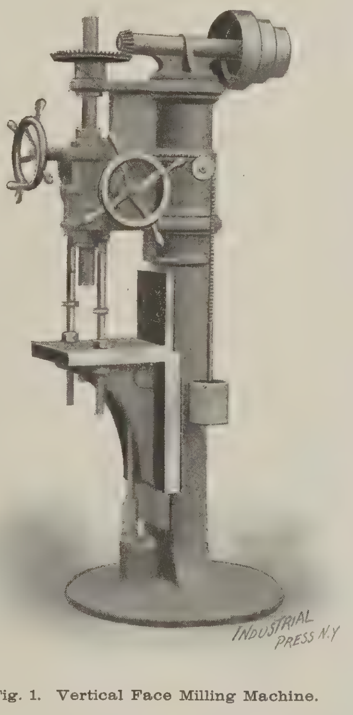


Fig. 1. Vertical Face Milling Machine.

The rapid and economical milling of large quantities of thin pieces is a problem that has been very satisfactorily solved at the U. S. Armory by the vertical milling system that is here described. The Pratt & Whitney Co. build a special drill press, illustrated in Fig. 1, that is admirably adapted to this class of work, but an ordinary drill press may be utilized by placing a jack under the table so as to prevent springing. The table and head must line up very accurately and be retained in that relation in order to obtain satisfactory results. The milling is performed with the face mill shown in Fig. 2, which fits the spindle of the drill. This mill is about 6 inches in diameter and has a pilot *A* which fits the center hole *B* in the milling fixture shown in Fig. 3. In making this mill the distance between the teeth must be less than the length of the pieces, otherwise they will be pulled out of the fixture when they are being operated upon. Oil is fed onto the work by pouring it on top of the mill, whence it runs down through the numerous holes *CCC*.

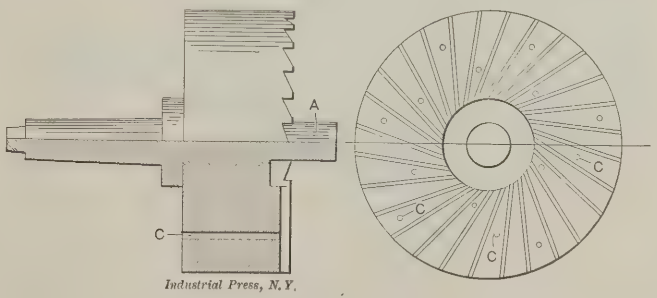


Fig. 2. Face Mill.

The milling fixture is made on the principle of a drill jig with a leaf *D*, which is hinged at the pin *E*. The top of the base is ground true with the bottom of the legs. The base is a permanent fixture to which may be attached different leaves to suit the size and shape of the pieces to be milled. These leaves are planed on top and bottom and are screwed and doweled to the hinge, a special jig having been made for this purpose. The leaves have as many openings in them as the space will allow; with irregular pieces one row is usually all that can be used, but with small, regular pieces, as shown in the drawing, two or more rows may be employed. In making these openings, which must be a good fit for the pieces they are to hold, we first make a hardened templet having a hole of the required shape. This is clamped to the leaf and the holes are drilled out and then profiled, using a mill that has a shank of the same diameter as the cutter. This shank acts as a pilot pin and the templet guides the cutter so that it is possible to mill all but the sharp corners and very little hand work is required. The holes may all be located at the same distance from the center of the leaf by fastening the templet to a piece having a pin to fit the center hole *B*.

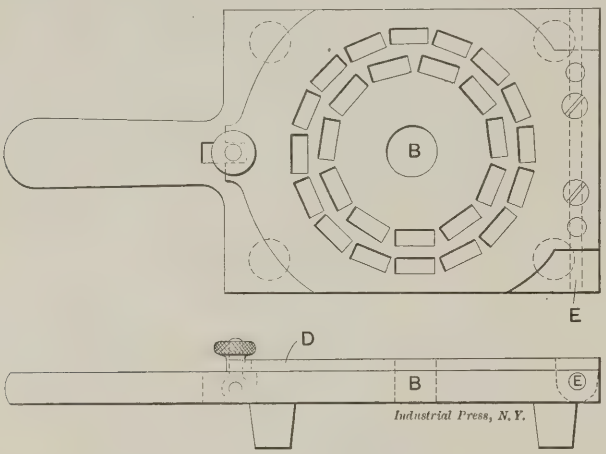


Fig. 3. Fixture for Face Milling.

To operate the fixture, fill the openings with the pieces to be milled and place the fixture under the mill, then feed the mill down onto the work. The pressure of the cutter keeps the work in place. When pieces are to be milled on both sides, after one side has been milled the leaf with the work in place is removed from the hinge, turned over and replaced and the second side is milled in the same manner as the first.

Springfield, Mass. C. H. Wilcox.

ON THE SUBJECT OF FRICTION.

Editor Machinery:

We so often read statements in advertising literature regarding the reduction or abolition of friction that some of our unmechanical friends might conclude that friction is our worst enemy, or at least a necessary evil. It is, however, more necessary than evil for, though the thought rarely enters our minds, it is nevertheless true that without friction every engine in the country would immediately go to pieces and, also, we should be unable to walk a single step. Now, like all phenomena in nature, friction is the more useful to mankind as he learns to make use of it in the proper manner for each purpose. Lack of ability or judgment in doing this has frequently produced failure. Friction is the worst enemy of the perpetual motion fiend, but it is the friend of the primitive savage who could not build his fires without it. If the reader has never yet attempted to produce a fire by rubbing together two pieces of wood he had best try the experiment, though, like one of Jules Verne's characters, he will doubtless become warmer than the wood.

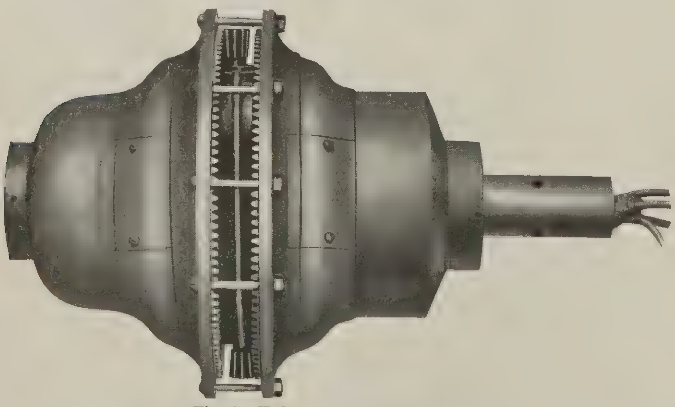


Fig. 1. Holson Couple-gear Motor.

There are some peculiarities about friction that should be better understood. One of these is the rule that the total amount of friction is independent of the area of contact. This is often interpreted literally or, rather, other factors arising from changes in the bearing area are ignored. Sometimes an increase in bearing area, by reducing the pressure per square inch, permits better lubrication with a resulting decrease in friction; whereas in other cases, as where adhesion or atmospheric pressure are active, an increase in bearing area may increase the total friction. Such results are not antagonistic to the general laws of friction but are the results of other elements entering in and modifying the result. The necessity of proportioning the amount of friction to the requirements has furnished ample opportunity for the exercise of inventive power and numberless are the arrangements and devices that are used to reduce friction on the one hand and to increase it on the other.

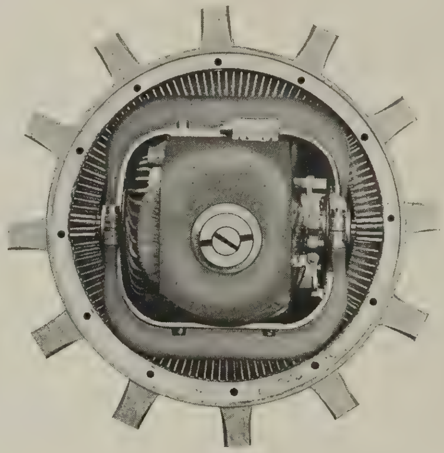


Fig. 2. End View with Casing removed.

For reducing friction we have ball and roller bearings, pivots, jeweled bearings and bearings floating in mercury or magnetically supported; while to increase friction substances having a high coefficient of friction upon each other are employed, or such a substance as sand, in railroading, is inserted between the surfaces. It is also in railroad work that "traction increasers" are used in which the friction is increased by placing additional weight upon the drivers. There is, where it can be practiced, no better way of reducing frictional losses than to do so by judicious design, not simply of the bearings themselves, but of the working parts in relation to each other.

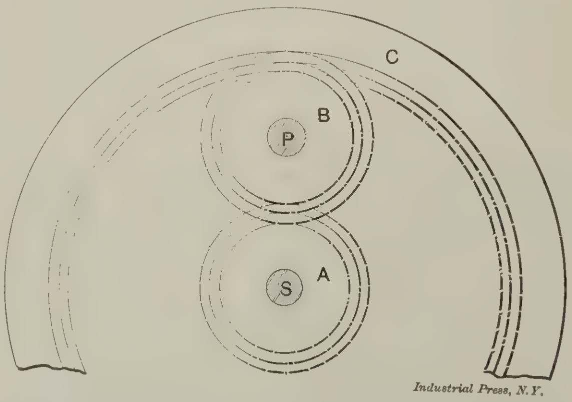


Fig. 3. Arrangement of Gearing in Old Windmill.

One of the best mechanical devices of this order that has come to the writer's notice is the Holson "couple-gear" motor, used on motor vehicles, and illustrated in Figs. 1 and 2. Fig. 1 shows each of the two pinions engaging one of the large bevel gears, while in Fig. 2 a view at right angles to that in Fig. 1, the hub is shown with the outer half, containing one of the large bevel gears, removed to show both of the pinions. It will be seen that power is taken from both ends of the armature shaft, dividing the pressure due to driving between both bearings; and incidentally the driving member, or vehicle wheel in this case, is driven equally at two diametrically opposite points. A couple is thus produced by the driving pinions so that there is no friction in the bearing due to its being driven. An accurate test of this device shows it possesses a very high mechanical efficiency.

Quite another arrangement of gearing is illustrated in Fig. 3 and was used in a windmill. In the drawing, *S* is the wheel shaft carrying the pinion *A* which drives the internal crank gear *C*, through the pinion *B*, with a reduction of about 4 to 1. At the first glance there may not seem to be anything unusually unmechanical in the arrangement as here shown but when the writer was asked to examine this windmill, on the farm where it was in use, the proportions did not appeal to him very strongly. The design was such that pinion *B* was quite small and the stud *P* upon which it ran was also small and short. Besides this the manner in which the gear transmitted its power placed its bearing under twice as much pressure as that on its teeth so that, roughly figured, the pressure on the bearing was found to be so great that proper lubrication was impossible and the mill was soon condemned for that reason.

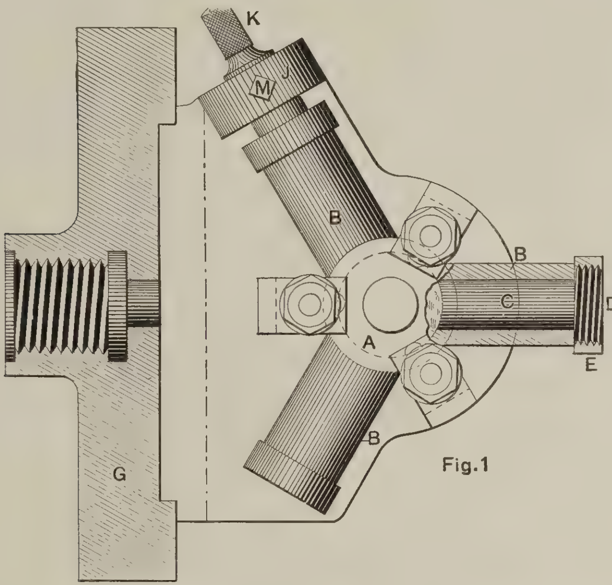


Fig.1

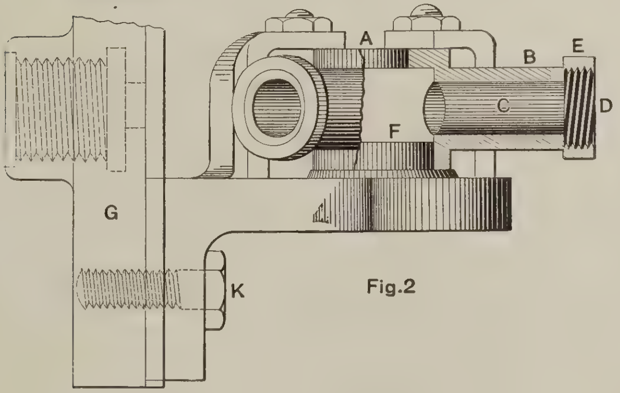
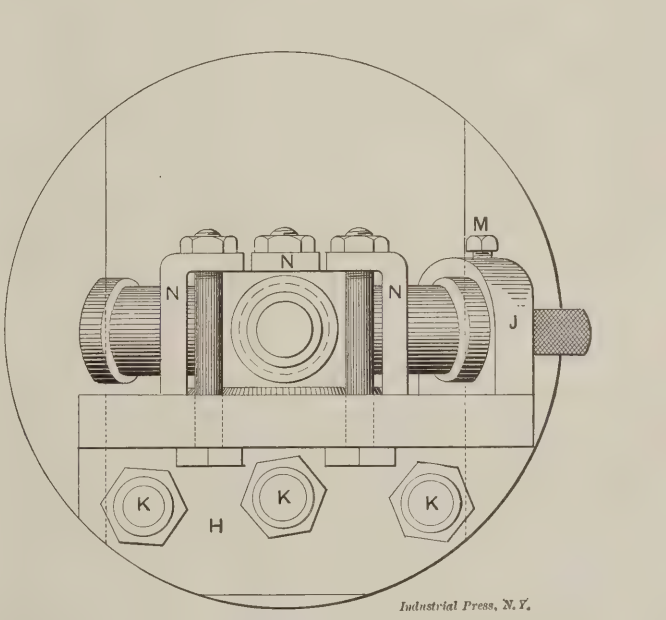


Fig.2



Industrial Press, N. Y.

Fig.3

Fixture for Chucking Gasoline Engine Cylinders.

This subject of reducing friction by arrangement of moving parts as well as by good design of the bearing is far too broad to be given full discussion in the limits of a single article, but the two devices here shown, one a success and the other a failure, serve to illustrate the principle.

Grand Rapids, Mich. CORNEIL RIDDERHOF.

A SPECIAL CHUCKING FIXTURE.

Editor MACHINERY:

Not long ago while visiting a manufacturing and jobbing shop, the writer saw the chuck illustrated in Figs. 1, 2 and 3, which contains some points of interest that might be adapted to the rapid production of any work of a character similar to the pieces for which this chuck was designed. The casting for holding which this chuck was made was, as will be seen, of rather unusual shape. It formed a triple cylinder for a high-speed automobile engine which was being manufactured in the shop. It had three cylinders, *BBB*, which were required to be bored out and reamed to size at *C*, turned on the outside at *E*, and counterbored and tapped for plugs at *D*. The portion indicated by the letter *A* was the hub. The centers of all three cylinders had to be on the same plane and spaced so as to form exactly the same angle with each other.

The construction and use of the chuck will be seen by reference to the three views shown in the illustration. *G* is a faceplate, turned and finished to screw onto the lathe spindle and channeled down the face to allow of locating the angle plate *H* which is fastened to it by the cap screws *KKK*. The hub of the casting was first held in another chuck and bored out on the inside and finished on the outside to gages. This preliminary work formed the basis for the accurate accomplishment of all of the succeeding operations. The work was then located centrally on a boss *F*, formed upon the bracket *H*, so that the three cylinders would come approximately central. For clamping the three straps *NNN* were used; while the indexing was accomplished by plug *K*, Fig. 1, whose locating part was hardened and ground to fit the finished bore of the cylinder and also the reamed hole in the lug *J*.

When using the chuck, a casting was first clamped somewhat loosely upon the angle plate *H*, being located centrally by the stud *F* which projected upward about ¼ inch. A plug, which for a distance along its length fitted the reamed hole in the lug *J* and for the rest of its length fitted loosely in the cored holes in the cylinders, was inserted, through the lug, into one of the cylinders. The clamps were then tightened and the machining proceeded. First the outside of the cylinder was turned at *EE* and finished to gage, after which the steady rest was brought up and adjusted so that the finished portion ran true in it. This was followed by the boring and reaming which were done by first using a bar with an inserted cutter, then a shell-rose reamer, and finally a one-bladed reamer for finishing. After reaming the counterboring and tapping were done. Now the clamps were loosened and slid back, the work removed from the angle plate—the temporary plug having, of course, first been removed—and the casting relocated with the finished cylinder in line with the lug *J*. The plug *K* was inserted, through the lug, into this cylinder which it fitted perfectly. The setscrew *M* was tightened, thereby holding the plug securely in place, after which the clamps were secured and the second cylinder was bored, reamed and tapped as had been done with the first. After this the same method of procedure was followed for finishing the third, or remaining cylinder. TUBAL CAIN.

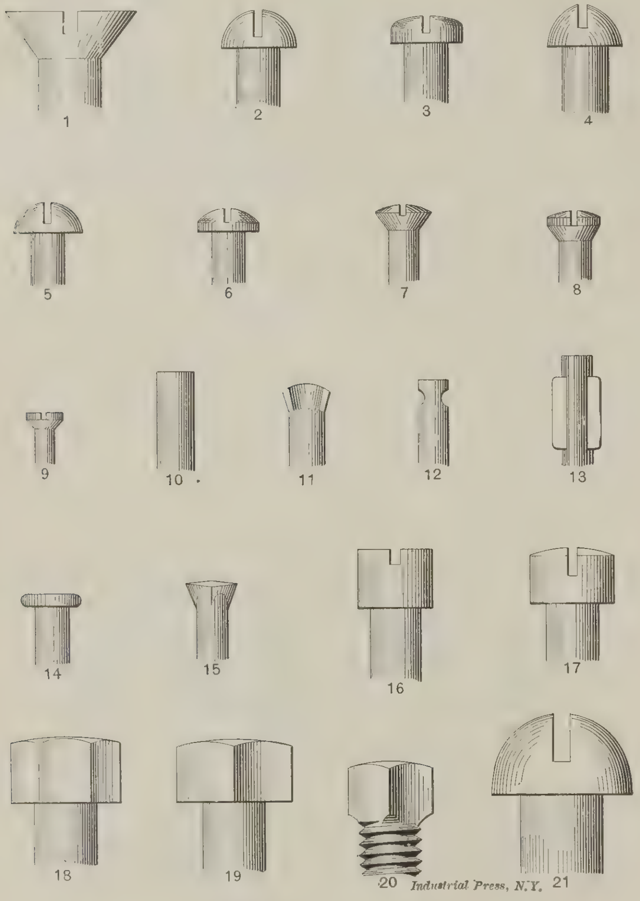
SCREW HEADS.

In the division of screws into classes the head forms an important part, and the name of the head is in most instances the method of distinguishing between the different classes of the same kind, as *round head* wood screws or *flat head* machine screws. The most common kinds of heads are easily learned, but even these are often a source of confusion to the young man beginning the business, while the styles of head not commonly seen in the hardware stock are a mystery to all those who have not had especial reason to learn them. The following brief description of each may help to fix the differences in the minds of those not already acquainted with the different styles.

1. Flat or countersunk head, used on all flat-head wood and machine screws, and on flat-head stove bolts. The top of the head is flush with the surface when applied.

2. Regular round head, used on round head wood screws and stove bolts and on machine screws. The head rests upon the surface of the object to which it is applied.

3. Regular round head used on machine screws larger than 5-16 inch diameter. This also is above the surface when applied.



Forms of Screw Heads.

4. Regular round head used on piano screws only. This differs from the round head used on wood and machine screws in the fact that it is higher.

5. A new round head used on piano screws only. This head has a larger base than the ordinary round head to give it a greater binding surface.

6. Fillister head used on piano screws. This head has also a large base to hold firmly to the surface upon which it rests. This screw is used in the piano action.

7. Regular oval head used on wood and machine screws. In application the edge of the head is flush with the surface, the slightly oval top rising above it, to give a better finish.

8. Oval head improved. Applied in the same manner as No. 7 and having the effect of giving a heavier or stockier head of the same diameter and surface contour as the regular oval. Used largely by gunmakers in attaching the plates to the locks of guns.

9. Head used on butt plate wood screws and damper block piano screws.

10. Headless, made with either wood or machine screw thread. These are used in castings where they are set into the piece cast with the screw protruding. Customers also buy them in this way and fashion the head into any special shape desired. Often furnished with heads slotted, and in use driven with top below the surface.

11. Pinched head used in castings with either wood or machine screw thread. The shape of the head keeps the screw from turning in its place.

12. Grooved head used in castings with either wood or machine screw thread. The groove is formed by pinching the rod and holds the screw fast in the casting.

13. Winged head, either wood or machine screw. When this is used a hole is first bored into the wood to receive the head and it is then driven to place, with the screw protruding, as in base knobs. The hole is the same diameter as the body of the screw. The wings keep the screw from turning.

14. Round bung head, used with wood or machine screw thread. Screws with this head are used in various ways. Many of them are used in the balls of curtain pole fixtures, being soldered into the ball.

15. Square bung head, used with wood or machine screw thread, in castings.

16. Flat fillister head, used with machine and cap screws. Used in machinery, usually with the head set in flush with the surface, in places where one part of the machine slides upon or passes over another.

17. Oval fillister head used on machine and cap screws. This is often countersunk the same as the flat fillister head, leaving the round above the surface for the finish, but is also used with the entire head above the surface.

18. Hexagon head used upon cap screws and machine bolts, and turned with wrench.

19. Square head used upon cap screws and machine bolts, and turned with wrench.

20. Square head used on set screws. The head of a set screw is always of the same diameter as the body of the screw and the thread is cut to the head. These are made with a variety of points, such as round, flat, cup, cone, hanger pivot, flat pivot, round pivot, etc., all shown in the Screw Department catalogue.

21. Button head used upon cap screws. It is slightly higher than the regular round head used upon wood and machine screws.—*From Circular of P. and F. Corbin Co.*

* * *

ITEMS OF MECHANICAL INTEREST.

PUNCHING SEAMLESS TUBES—PORTABLE BORING MACHINE—SENSITIVE FEED DEVICE FOR DRILL—NOVEL ROTARY PUMP.

The recent improvements on the line of the London, Brighton & South Coast Railway in England comprise a bridge over the tracks of the London & Southwestern Railway which is remarkable for having one span in which the girders are 150 feet long from the centers of the column supports. The construction is of the single triangulation or N type with the upper boom curved.

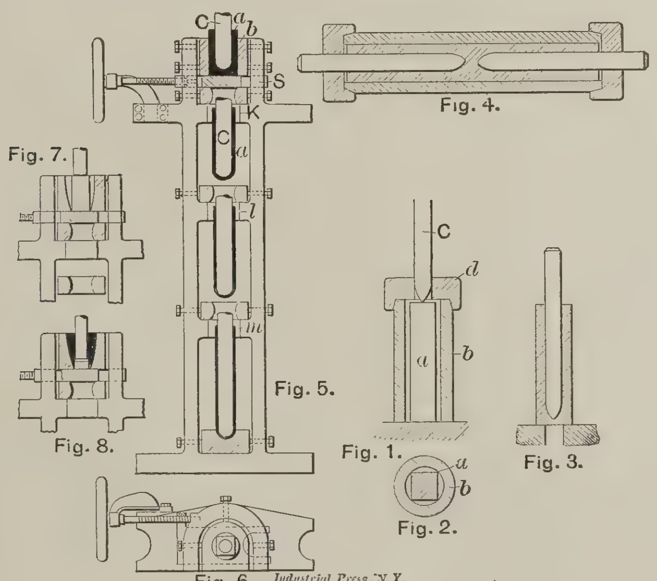
A rule recently published in the *Scientific American* for finding the power of windmills, is as follows: Find the square area of the slats in the wheel in the plane of revolution. This may be assumed to be the same as that of a circle of the diameter of the wheel. Multiply the area by the cube of the velocity of the wind in feet per second. The product divided by 4,000,000 gives the horse power. Example: What is the horse power of a wheel 12 feet in diameter in a wind blowing 15 miles per hour? Area of the wheel equals $12^2 \times .7854 = 113$ square feet. 15 miles per hour is a velocity of 22 feet per second. $22^3 = 10648$ which multiplied by 113 and the product divided by 4,000,000 gives 0.3 horse power.

A factory has been started at Hoslund, Norway, by C. G. P. DeLaval, of cream separator and steam turbine fame, to exploit his electric process for the extraction of zinc from the ore. The process consists essentially of an improved electric furnace which is not only adapted to the reduction of zinc ores, but many other ores. The gist of the improvement consists of means for the continuous introduction of the ore to the furnace and means for preventing the finely-crushed material being scattered about by the gases generated by the intense heat. The difficulty in separating the volatile gases from the pulverized ore that is thrown about by the violent chemical processes incident to the great heat has been heretofore one of the chief obstacles to the use of the electric arc in the reduction of certain ores.

The property of a vacuum by which a negative condition enables the atmospheric pressure to produce a positive result was formerly a great mystery to mankind. The Greek philosopher, Aristotle, the pupil of Plato and the teacher of Alexander the Great, explained the rising of water in a pump and similar manifestations of atmospheric pressure "because Nature abhors a vacuum," and it was nearly two thousand years until the time of Galileo—by whom the phenomenon was logically demonstrated as being caused by the weight of the air. And it would be not beyond belief to find that the true meaning of Galileo's discovery had not yet percolated through the skulls of all present-day gentlemen who make some pretensions to knowledge of physics and kindred sciences. But, nevertheless, we can scarcely repress a smile, strive as we may, at the naive remark of a prominent member of New York City's fire department, who, when asked at the trial of Edward Croker (late chief of the fire department), to define a vacuum, is alleged to have said "a vacuum is an inch of nothing."

PUNCHING OUT SEAMLESS TUBES.

Apropos of the interest that is now being manifested in the United States in the manufacture of hollow axles and the method of producing them, a description of the method employed in the town of Montbar for making seamless tubes of circular section by punching them from square bars may be in order. The process is one of punching and die forging simultaneously. To get a tube of circular cross section, there is introduced into the mold a matrix, or die, *b* (Figs. 1 and 2), a square bar *a*, heated to cherry red, and of such dimensions that its diagonal equals the diameter of the cylindrical die, this having the object and result of exactly centering the bar which is to be expanded in the punching process. The cap *d* serves as a guide to the punch *C*, which latter has the diameter of the required bore of the tube. The calculation of the minimum quantity of metal necessary to give a tube of a given diameter is very simple.



Industrial Press, N. Y.

Thus, for a tube of one inch external diameter the punch must have a diameter of 0.603 inch for the metal just to fill the mold. This gives walls of 0.1985 with thickness. Where thicker walls are desired, for a given external diameter, the bar must evidently have its corners truncated or its sides rounding so that there will be less space between the bar and the mold, and the area of the punch must just equal this space. For a thinner tube, the sides of the bar may be concave. The punch does not go all the way through; the plug left at the bottom (see Figs. 3 and 4) must be drifted out or otherwise removed. For long tubes, two punches are employed, working in opposite directions as in Fig. 4.

The friction of the bar on the die is so great that the pressure of the punch on the bar is comparatively low. Figs. 5 to 8 show in principle but not in detail a machine for making tubes from an ingot *a* of any desired cross section. This is first stamped by the punch *C* in a die *b* closed by a sliding piece *S*, which can be used to close the bottom of the die, by means of a screw and handwheel. The preliminary punching having been effected, the piece *S* is withdrawn and the punch continues its course, driving the metal through a series of dies *X*, *l*, and *m*. Another way is to use a punch-shaped matrix of special form, shown in Figs. 7 and 8.

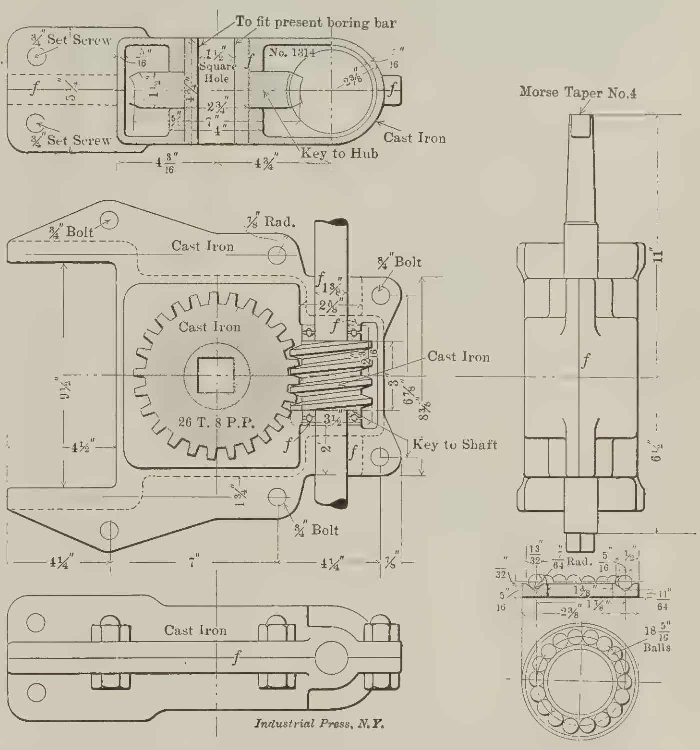


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Fig. 9. Portable Worm-driven Boring Machine.

The precision attained by this work is remarkable and the polish surprising. Shrapnel are made, with a thickness of wall of only 2 millimeters or 0.08 inch "scant." For very long tubes the short tubes resulting from the punching are drawn further in dies, without being allowed to get cold; they will stand three redrawings without reheating. When the wall is not more than 3½ millimeters or 0.14 inch thick, cold drawing on a mandrel suffices. It is not necessary to heat beyond a cherry red.

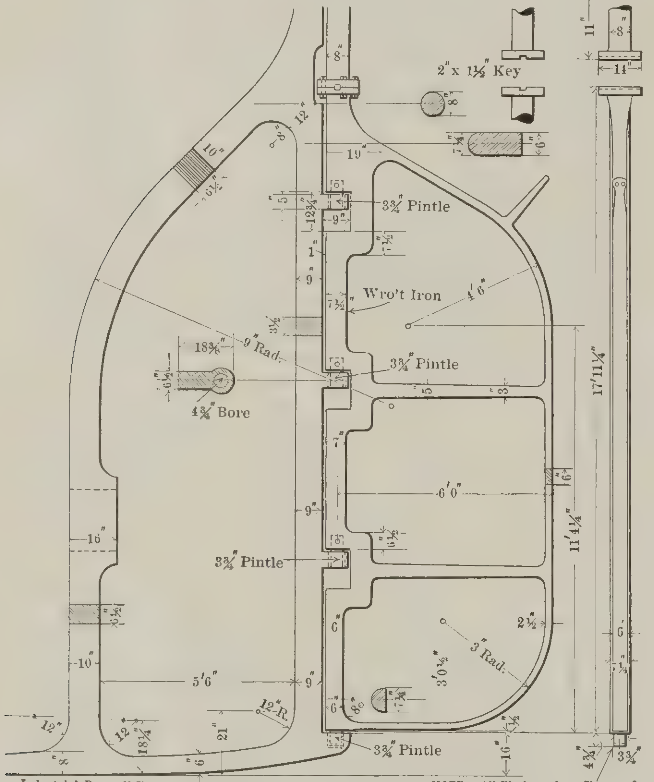
In the first experiments made in Germany, the hydraulic plungers had a diameter of 0.50 meter and a stroke of 1.10 meter or 20 inches diameter, 44 inches stroke, and with 90 atmospheres pressure, tubes were produced up to 60 millimeters or 2.364 inches diameter. At present the same press works at 180 tons pressure and produces tubes up to 240 millimeters or 9.46 inches diameter. In Dusseldorf there are several such presses at work, making gun barrels, etc., at one quick pressure. The limit of exactitude of diameter or of thickness is one-tenth of a millimeter or four thousandths of an inch.

In Dusseldorf there are made by this process boiler tubes, steam pipe, and all sorts of tubes, hollow axles, shells for cannon, cannon barrels, and reservoirs for compressed gases, up to a pressure of 250 atmospheres. The pressure exerted on the material in manufacture condenses it and increases its tensile strength; at 500 atmospheres the reservoirs tear but do not burst. The steel employed must have a tensile strength of from 41,000 pounds to 129,000 pounds per square inch and a coefficient of elongation of 15 to 30 per cent., both of which are increased by the process of manufacture.

Hanover, Germany. *Robert Grimshaw.*

PORTABLE WORM-DRIVEN BORING MACHINE.

The portable worm-driven boring machine shown in Fig. 9 is one that was made some two years ago by the Chicago Shipbuilding Company for boring the holes in stern-posts for rudder pintle bearings. It consists of a hollow cast-iron frame made in two parts and tightly inclosing a worm and cast-iron wormwheel of 26 teeth, having a square hole through the hub for the reception of the square boring bar or the head of a reamer. The frame is made with two opposing jaws having setscrews by which the device can be securely clamped to the rudder post or other work when in use. The worm is also made of cast iron, and its thrust is taken by ball bearings. The feature of ball bearings is an essential one as it not only greatly increases the mechanical efficiency, but reduces the causes for heating. The motive power is connected by means of a Morse No. 4 taper socket fitting the end of the worm shaft. Since the worm is single thread and the number of teeth in the wormwheel is 26, it is obvious that the leverage of the driving motor is greatly multiplied, making it possible to use a motor of comparatively weak torque to drive a heavy cut.



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NOTE: All Pintles to have Sleeves of Seamless Brass Tubing 3¾" I. Dia. x ¼" thick. Bearings to have ¼" of Babbitt outside of Brass Sleeve.

Fig. 10. Stern Post and Rudder for which Portable Boring Machine was used.

The particular job for which the rig was designed, is shown in Fig. 10, being the working drawing of a stern-post and rudder for (four) vessels built by the company. The pintle holes in the stern-post are, in this case, 4¾ inches diameter and 5¼ inches deep while the pintles are only 3¾ inches diameter. The difference in diameter is made up by a brass sleeve ¼ inch thick with which each pintle is bushed, and a babbitt lining ¼ inch thick in the stern-post. The device is also used for boring the sockets for the pintles, in the rudders. It is, of course, applicable to a large range of other work in shipyards and general manufacturing plants where portable apparatus is used.

INGENIOUS SENSITIVE FEED DEVICE.

The feed device of the hand drilling machine shown in Fig. 11, is a somewhat ingenious English adaption of the steam engine centrifugal governor principle, the drill spindle being moved downward through a limited distance by the outward tendency of the balls, the same as the valve stem of a fly-ball governor. In effect it forms a sensitive feed device in which the pressure developed between the point of the drill and the work depends on the speed with which the machine is driven The balls also act as a flywheel to keep the motion steady. When the hole is drilled and the machine is stopped the drill automatically lifts out of the hole as the balls drop. One obvious disadvantage of this principle is that the pressure of the feed is in inverse ratio to the size of the drill, provided, of course, each size of drill is driven at its proper cutting speed. For small hand drilling machines, however, in which the range of drill sizes is narrow, this objection is of little weight.

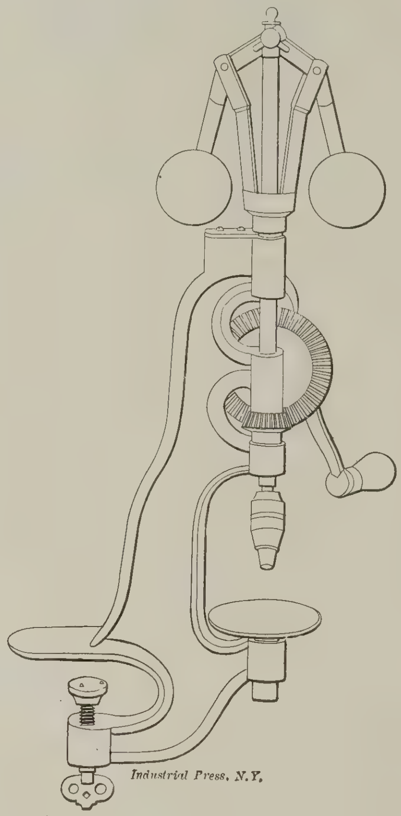
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Fig. 11. Sensitive Feed Device.

NOVEL PUMP.

The *Horseless Age* recently described a novel, so-called rotary pump, invented by A. Butin and manufactured by the well-known automobile concern, De Dion & Bouton of Puteaux, France, presumably for automobile purposes. Although referred to as a rotary pump, it is really an oscillating piston pump, the piston being semi-circular and oscillating in a hemispherical case. But, because of the peculiarity of construction which makes the plane of oscillation rotate with piston, it is possible to dispense with inlet and discharge valves. This is because one port acts constantly as a suction port and the same applies, of course, to the discharge port, as will be seen further on. The case *B*, Fig. 12, is secured to the end of the base casting *A* so as to form a water-tight joint. The shaft *L* transmits motion to the oscillating piston *C* through the medium of the crosshead *E*. This piece is bored throughout

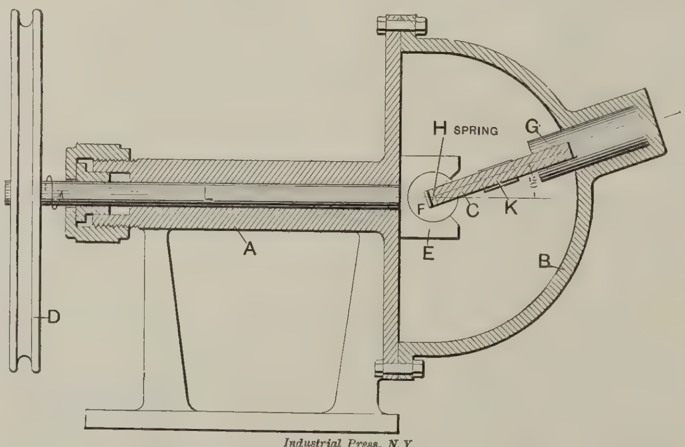

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Fig. 12. Novel Form of Rotary Pump.

its length to receive the small rocking cylinder *F*, and it is slotted along one side for the piston *C*. The cylinder *F* is grooved to receive the piston and a flat spring *H* is laid in the groove to keep the piston constantly against the inner wall of the case. A bearing for a short shaft *G* is bored in the case at an angle of 20 degrees with that of the shaft *L*. The inner end of the shaft *G* is slotted to receive the outer edge of the piston *C*. Two ports for suction and discharge are provided in the case, oppositely situated. One of the ports is shown at *K* directly beneath the piston *C*. In this position which is the maximum angle made with the driving shaft, both ports are closed by the edge of the piston.

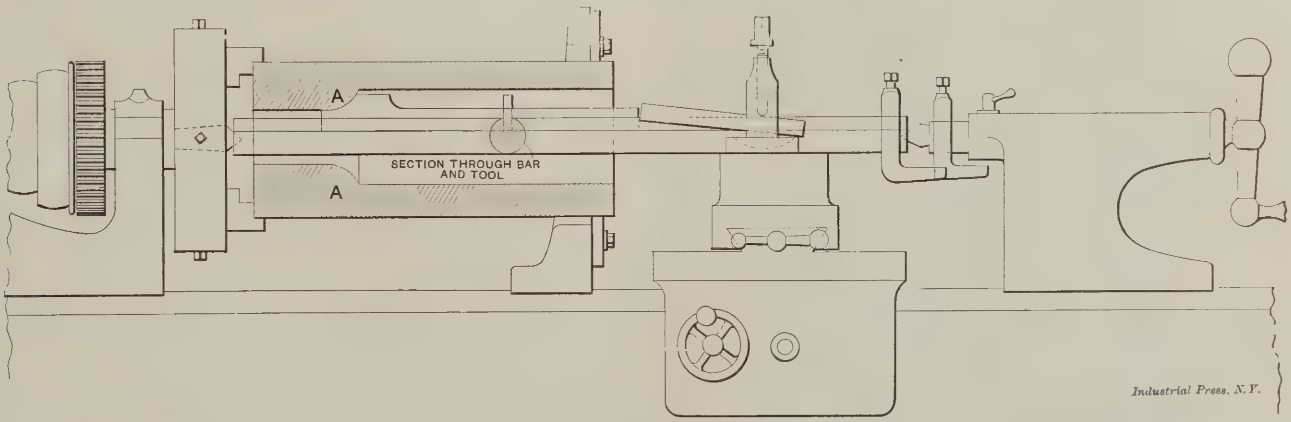
The operation is as follows: the crosshead *E* and disk *C* divide the chamber formed by the casing *B* into two compartments, which are constantly varying in volume as the disk rotates, one decreasing in volume while the other increases. In the position the disk occupies in the drawing the upper compartment has a minimum volume and the lower a maximum volume, and as the disk continues to rotate, the compartment which is now the upper constantly increases in volume for a half a revolution of the disk. During the entire time this compartment is in communication with the suction port and water is drawn into this compartment equal to the increase in volume. When the compartment has reached its maximum volume it is closed to the suction port and opened to the discharge port by the motion of the disk. During the next half revolution of the disk the volume of the compartment considered constantly decreases, and, as the compartment is open to the discharge port during this half revolution, the water is forced out through this port.

* * *

CONTRIBUTED NOTES AND SHOP KINKS.

BORING A ROUND SHOULDER.

G. Trueger sends us a description of a job that he recently had to do, and the method by which it was done may serve as a suggestion for accomplishing a number of jobs of a similar nature which are often encountered. On the inside of a cylinder it was necessary to round a shoulder that was about 12 inches deep, as shown at *A* in the sketch. It was found that this could not be done with an ordinary tool held in the toolpost, owing to the spring and chatter of the tool, so the arrangement illustrated was devised. The casting was first bored and reamed in the usual manner being held in a lathe chuck with the outer end supported in the center rest. A 1½-inch shaft was centered and a keyway, 5-16 inches wide and ⅝ inches deep, was cut its entire length. This shaft was placed on the lathe centers and prevented from turning by using two dogs on the tailstock end. The cutter consisted of a piece of tool steel of suitable width to just slide freely in the slot of the bar and shaped on the front end to the required radius of the corner. It was of sufficient length to extend out in front of the hole and was fed up to the work by a bar held in the toolpost. The results of this boring were very satisfactory, the corners being round and very smooth.



A CONVENIENT SCRATCH GAGE.

M. H. B. sends the accompanying sketch of a scratch gage which, he says, is better adapted to all kinds of work, around circles, close to corners and shoulders, etc., than any other that he has seen. The head is a steel block with a V-groove on one side and holes through it, both lengthwise and crosswise, to receive the bar which is secured in either position by the gib and screw as shown in the figures. By reversing the bar, as in Fig. 2, the tool is made capable of its closest work into corners, etc. The scratch point is a square, flat piece of hardened steel beveled off on the outside corners and fastened by a button head screw passing through its center and binding it to the end of the rod.

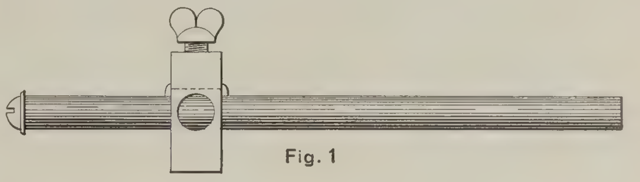


Fig. 1

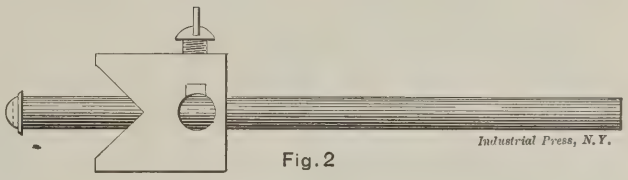


Fig. 2

SCRIBING A CENTER LINE ON WORK HELD IN THE INDEX CENTERS.

It is often required to scribe a center line on gear blanks, or similar work, held in the index head and the following method, contributed by G. G. P., will be found an easy and accurate way of doing this. Set the scriber on the surface gage as near as possible to the height of the center of the index head and scribe a short, fine line on the face of the blank. Then index half way around and make another line on the same side of the blank as the first and if the scriber was set central with the head the two lines will coincide, forming a single line. If the scriber was not set central the two lines will be a short distance apart and equi-distant above and below the center so that, by setting the scriber midway between these two lines and trying again as before, a center line can be quickly and accurately made. Now by indexing one-quarter of the way around this center line will be brought exactly on top and central so that the center line on the cutter can be set to it.

If the cutter has no center line, make two lines which shall be equi-distant each side of the center, by setting the scriber a little above or below the center of the head and making one line, then indexing around and making another line on the same side of the work as the first. Now if we index one-quarter of the way around it will bring these two lines on top and in central position so that the cutter can be set midway between them. When the scriber has once been set at the exact height of the center of the head it is well to scribe a line on some part of the head, which will aid in setting at any future time.

* * *

A writer in the *Electrical Review* gives a formula for a solder to be used as a protection to telephone apparatus, which melts at a temperature of 160 degrees. It consists of lead, 2 parts; tin, 4 parts; bismuth, 7 parts; and cadmium, 2 parts.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

1. A. S. C.—Is there any less expensive metal or alloy used as a substitute for platinum for electrical purposes?

A.—There is a compound, imported from Europe, called "latinum" that is largely employed by telephone makers in the place of platinum for contact points. The price is $13.00 per ounce, and as it is but one-half as heavy as platinum, the actual cost is about one-third as great.

Another substitute for platinum, used for an entirely different purpose, is "platinite," which is an alloy of nickel and steel. It is possible to make this compound in such proportions that its coefficient of expansion is equal to that of platinum. For this reason it can be used in the place of platinum in the manufacture of electric lamps. It has been the custom to use short sections of platinum wire in incandescent lamps because, up to a few months ago, it was the only metal known having the same coefficient of expansion as glass. As stated, "platinite" is now used to some extent for the same purpose.

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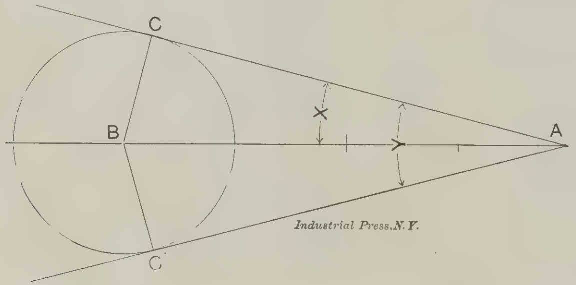
2. W. S. C.—Will you please tell me the angle of the sides of an Acme standard screw thread and explain how it can be laid out for making the thread cutting tool?

A.—The angle included by the sides of an Acme standard thread is 29 degrees. To lay out this angle, set the spacers to any convenient length and lay off four spaces on a straight line, as AB. At the end of the fourth space draw a circle having a radius equal to one of the spaces. From the starting point, A, draw two lines tangent to this circle and these lines will make each an angle of 14½ degrees with the line AB, or, in other words, will include an angle of 29 degrees. In proof of this: In the triangle ABC, $AB = 4 \times BC$. Therefore the sine of the angle $X = \frac{1}{4} = .25$, while the sine of 14½ degrees is .2504, showing that the angle is an extremely close approximation to 14½ degrees and the entire included angle Y is approximately 29 degrees.



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3. H. W.—Will you please tell me how to cut a right hand thread on one end of a chuck screw and a left hand thread on the other end so that both ends will start evenly in their nuts? 2. In milling slots on a taper reamer please explain how it should be set so that the sides of the lands will be parallel?

Answered by J. T. Giddings, East Providence, R. I.

A.—Scribe a line on the blank parallel with the axis and mark each end on this line where it is desired that the screw should start. Having the lathe geared up for the required lead, take up the backlash as by pulling the belt by hand. Suppose, first, that we are cutting a V-thread, right hand. Set the tool or work so that the point of the tool crosses or intersects the starting point on the scribed line, then, after cutting the right hand thread, shift the tumbler gears for reversing the direction of feed, turn the screw end for end in the lathe and, feeding toward the tailstock, set the tool so that it will cross the starting point at the other end of the screw. If this is accurately done it is obvious that both threads will start on a line parallel with the axis as required. If a square threaded screw is to be cut the leading side of the tool may be set to cross the starting point for the right hand thread and the following side should cross the mark for the left hand thread. If the stock from which the screws are made is long enough so that both screws may be cut without reversing the piece end for end in the lathe, the leading side of the tool may in both cases cross the starting points, provided the right hand thread is the one nearest to the tailstock of the lathe.

The nuts may be threaded in a similar manner. When threading the left hand nut in the lathe it may be conveniently done as follows: Have the inside thread tool bent around in the opposite way to that in which it is usually used and cut the thread with the lathe spindle running backward, the lathe carriage feeding toward the headstock. Then for both right and left-hand nuts the leading side of the tool may cross the starting points, and for the left-hand nut the tool can be seen when starting its chip.

2. Having decided upon the number of flutes, find the length of chords for circles for both the large and small diameters of the taper. This may be conveniently done by reference to the data sheet furnished with the Engineering Edition of MACHINERY in Feb., 1903. which gives the length of chords, for a diameter of 1, for all divisions of a circle up to 100. Multiply the values given in the table by the diameters of the large and small ends respectively and thus obtain the length of chords at each end. From these results subtract the required width of land and this will give the width of the groove in the reamer at the large and small diameters respectively. Then cut the groove in the small end nearly to the required width for a short distance, lower the table and move the large diameter of the reamer under the cutter and make a groove of nearly the required width for a short distance on this end. Then set the bottom of both grooves at the same height, by moving the spiral head through an angle. (Assuming the reamer to be held in a chuck in the spiral head or in centers on a special fixture which goes in the spiral head for milling tapers.)

The required angle could be obtained either by surface gage, the adjustable dial for knee screw, or it may be calculated as follows: Obtain the difference in height of the grooves, the axis of the reamer being horizontal, by means of the dial, then divide the difference by the length of the taper. For example: Suppose the difference in height is ¼ inch in a length of 6 inches. $.25 \div 6 = .04166$, and this is the tangent of the angle required. By means of a table of natural tangents we can then find the angle which, in this case, is 2 degrees and 23 minutes or approximately 2 1-3 degrees, which is the amount that the spiral head should be raised.

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4. E. E. E.—I should appreciate your best receipt for bluing steel. The steel has a nice finish and is not hardened. I want to get a nice blue for color.

A.—We do not know of any better way than the usual one of heating in sand or charcoal. The following description of the process is as clear as any that we have seen. It is taken from the instruction papers on shop practice issued by the International Correspondence Schools, Scranton, Pa., which contain many similar items of value to the shop man. "Polished work made of iron or steel may be given a beautiful blue color by heating it in hot sand, in wood ashes, or in pulverized charcoal. The substance in which the article is to be blued may be put into an iron kettle that is placed over a fire. The substance must be constantly stirred while it is being heated in order that the whole may be brought to an even temperature. The article or articles to be blued must be absolutely free from grease if an even color is desired. They may be placed in a wire basket or may be suspended by wires and then immersed in the heated substance until the desired color is obtained. A light blue color can be obtained by heating in sand or in wood ashes, but a dark blue color requires the article to be heated in pulverized charcoal. The brightness of the color depends largely on the finish—the higher the polish the more brilliant the color which will be obtained. The substance in which the heating is done should be just hot enough to char a dry pine stick. By this manner of bluing, a piece of work having thick and thin parts can be given an even color all over."

5. J. R. writes: Will you kindly inform me how to galvanize in an inexpensive way? I wish to galvanize round or flat wire and have it come out clean when finished.

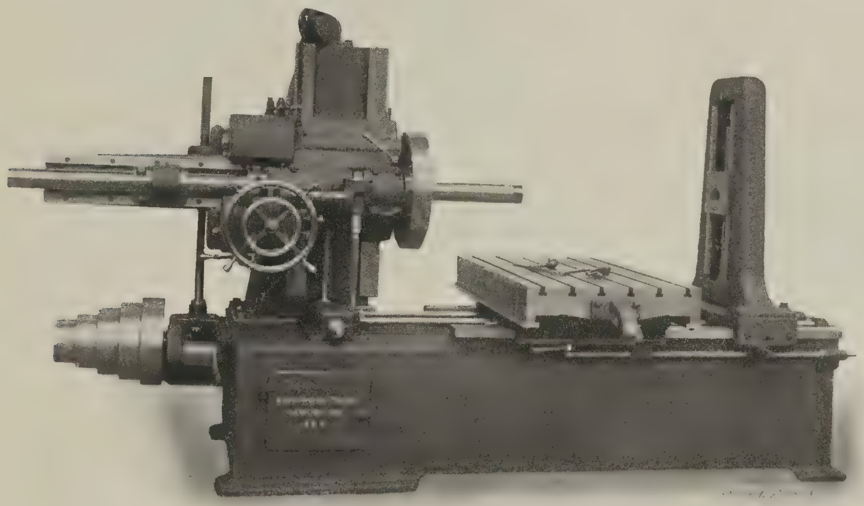
A.—We refer this to our readers for reply.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

The "precision" horizontal boring machine which has just been brought out by the Lucas Machine Tool Co., Cleveland, Ohio, is designed with a special view to accuracy and permanence of alignment, the lack of which has been the principal objection to the knee type of machine. These points are attained by making the spindle adjustable vertically instead of the table, thus moving the constant instead of the variable load. The advantages of this construction will be apparent. This construction permits of the use of a deep box bed carrying a table at a fixed height, this bed being much better able to resist the disturbing forces due to the cut and the weight of the work than the overhanging knee supported on screws.



Horizontal Boring, Drilling and Milling Machine.

To further insure against flexure, the bed is designed to rest on three points. Special attention has also been paid in the design, to arrange so that all operations can be carried on within range of the operator. The head is counterbalanced and is provided with a power elevating device as well as hand adjustment. The spindle is driven by an internal gear of large diameter and is powerfully back-geared. It is provided with both quick and slow hand motions which can be obtained instantly without throwing in any clutches or friction devices. The spindle may be fed 48 inches by two settings of 24 inches each.

The outer support for the boring bar is geared to raise or lower with the spindle, connection being made by a rod under the saddle, and an adjustment being provided whereby it can be corrected from time to time should it be required. The back rest is provided with means whereby it can be conveniently adjusted to any point along the bed and is made to be readily removed, when not required, without disturbing any of the working parts.

The gear feed box is provided on the head and is equipped with a reversing mechanism. The motion from this feed box can be readily converted to feed the spindle longitudinally, the table transversely, and the head vertically, the latter two feeds being milling feeds. The table is provided with automatic cross feed of 34 inches. The application of the cross feed to the table and the vertical feed to the head adapts this machine to a large variety of milling work. The elevating screw for the head and the table cross-feed screw have dials reading to thousandths.

The table is 30 x 48 inches, allowing a maximum distance from its top to the center of the bar of 26 inches and a distance from the spindle to the backrest of 5 feet, 6 inches. The machine is belt driven by means of a 3½-inch belt running on a five-step cone.

THE "HAMILTON" ENGINE LATHE WITH UNIVERSAL SCREW-CUTTING ARRANGEMENT.

The Hamilton Machine Tool Co., Hamilton, Ohio, have recently made extensive improvements in their engine lathes and are now placing on the market a new line of these machines in sizes from 14 to 28 inch swing and any length of bed. The headstock and tailstock, as well as the carriage and apron, have all received careful attention and have been redesigned and constructed to meet the requirements of the most advanced shop practice. The cross feed screws have micrometer adjustment and the tailstock spindle is graduated in inches for convenience in drilling. The apron mechanism is so arranged that it is impossible for the leadscrew and feed rod to be engaged at the same time, thus preventing breakages from this source. The longitudinal feed is powerfully friction driven, and all feeds are reversible from the apron. The leadscrew is used only for screw cutting, the turning feed being driven from a separate rod, and is not, therefore, liable to excessive wear.

The leading new feature of these lathes is the universal screw-cutting and feeding arrangement—an improved system of mounted gearing—giving a full range of screw pitches or feeds without removing a single gear, enabling the operator to change from one feed or thread to another almost instantly. This mechanism is illustrated in detail in Fig. 2 and is shown as applied to the 26-inch lathe in the half-tone, Fig. 1. It is not an attachment in the strict sense of the word but is in reality an integral part of the lathe. By its use any one of 48 different feeds or screw pitches are made available in but a few seconds.

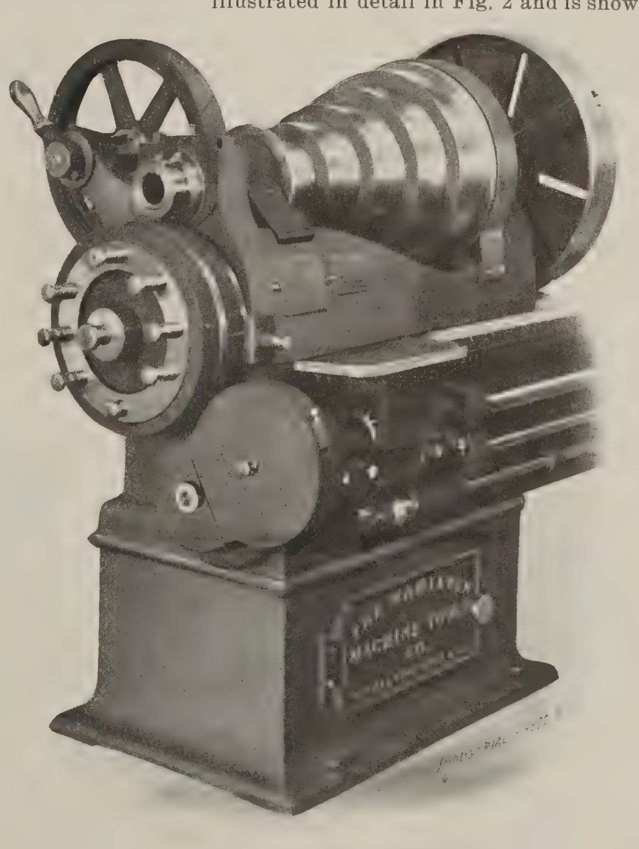


Fig. 1. Screw-cutting Arrangement of "Hamilton" Lathes.

As will be seen in the line drawing, the spindle gear *B* transmits the motion through the compounding gears *C* (of which only two are engaged at the same time), through the center pin *E*, to the driving gears *F*; these drive the lower clutch change gear *G* and connecting clutch gear *L*, which transmit the motion through the intermediate gear *M* to the leadscrew gear *P*. The circular gear box *J* may be rotated so as to bring any of the eight mounted clutch change gears *G* in mesh with the intermediate gear *M*. The reversing mechanism *R* is controlled from the front of the lathe apron by means of the reversing rod *V*. *S* is the leadscrew and *T* is the feed rod. The mounted clutch gears *G* are entirely independent of each other and are arranged so that only the one in use can be engaged. No adjustments are necessary in changing from one thread or feed to another.

leadscrew, 16 additional threads, from 2 to 7 may be obtained, and by using the 20-tooth slip gear, still another 16 threads from ½ to 1¾ are obtained, thus affording a total range of 48 threads or feeds. On this size of lathe the ratio between the feeds and threads is 8 to 1, and on the other sizes it is in proportion. To secure any desired feed it is only necessary to reduce it to the corresponding thread, by dividing by the ratio as given in the index, and set up the machine accordingly. These lathes are designated by the manufacturers as their style "A," in order to distinguish them from the regular pattern or style "B" lathes, having the ordinary loose change gears for screw cutting.

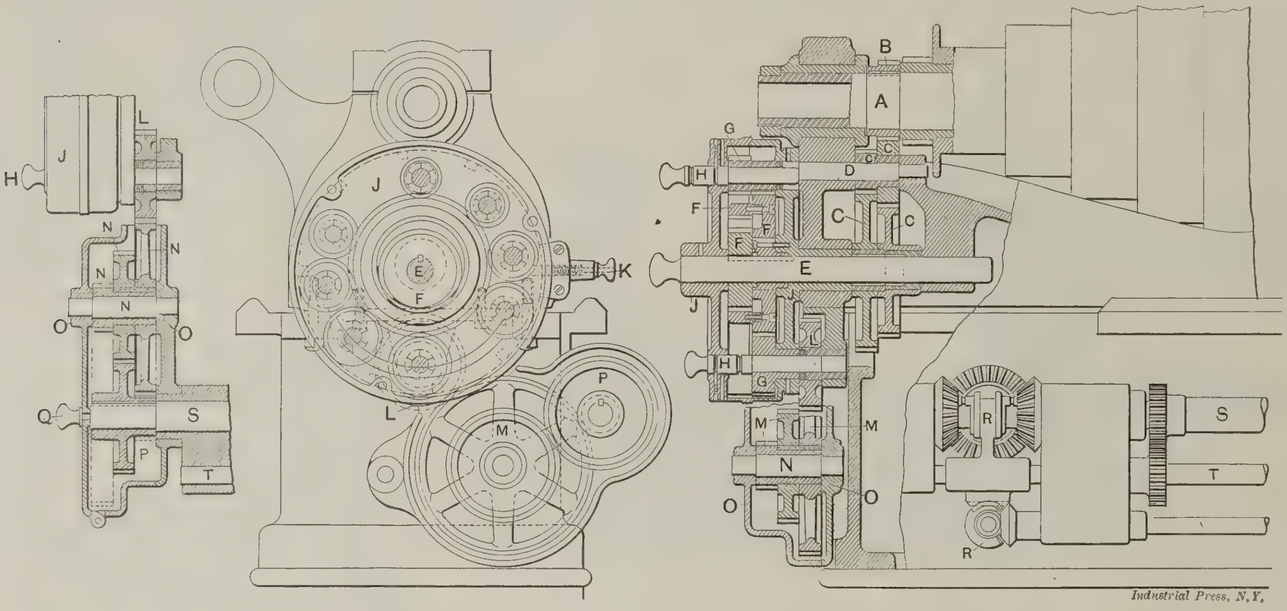
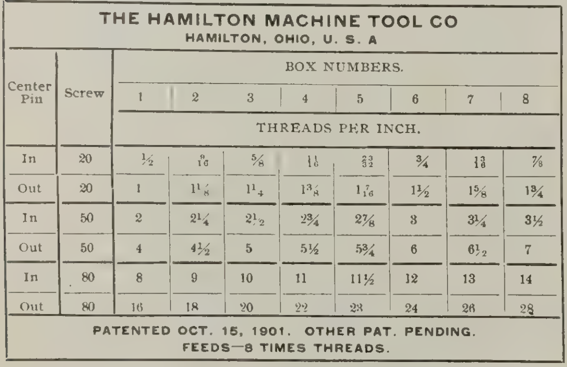


Fig. 2. Detail of Screw-cutting Arrangement used on "Hamilton," Style "A" Lathes.

Fig. 3 shows a *facsimile* of the index plate used on this, the 26-inch lathe. The words "in" and "out" in the column under "center pin" refer to the position of the sliding shaft *E*, in the center of the circular gear box. Under "screw" is given the required leadscrew change gear; three of these gears are provided, and they can be instantly slipped on or off as required. The "box numbers" are stamped on the circumference of the circular gear box and designate the different mounted clutch change gears *G*; the box should be rotated until the "box number" called for is opposite the pointer, when it is instantly secured in position by a spring locking pin; this brings the required "box" gear into mesh with the connecting clutch gear *L*, to which it is connected by simply pushing in the handle or knob *H* with which each "box" gear is provided. The knob on the gear in mesh is always at the lowest point of the circular gear box, and the arrangement is such that it is impossible to push in the wrong knob, thus preventing any error from this source. Referring to the index plate, it will be noted that if we employ the 80-tooth gear on the leadscrew, 16 different threads from 8 to 28 per inch may be cut without removing a single gear, the changes being made while the lathe is in motion, by simply rotating the circular box and setting the center pin as called for in the index. By placing the 50-tooth slip gear on the


THE HAMILTON MACHINE TOOL CO
HAMILTON, OHIO, U. S. A

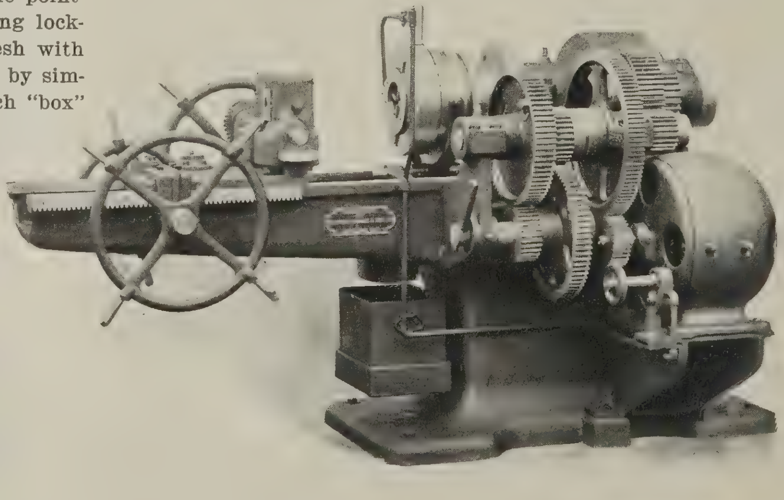
Center Pin	Screw	BOX NUMBERS.							
		1	2	3	4	5	6	7	8
		THREADS PER INCH.							
In	20	½	9/16	⅝	11/16	23/32	¾	13/16	⅞
Out	20	1	1⅛	1¼	1⅜	1 7/16	1½	1⅝	1¾
In	50	2	2¼	2½	2¾	2⅞	3	3¼	3½
Out	50	4	4½	5	5½	5¾	6	6½	7
In	80	8	9	10	11	11½	12	13	14
Out	80	16	18	20	22	23	24	26	28

PATENTED OCT. 15, 1901. OTHER PAT. PENDING.
FEEDS—8 TIMES THREADS.

Fig. 3. Index Plate of 26-inch "Hamilton" Lathe.

A NEW ELECTRICALLY-OPERATED BOLT CUTTER.

The Reliance Machine and Tool Co., Cleveland, Ohio, have just brought out a new bolt cutting machine which is a decided departure from what has hitherto been their standard type of machine. This is the 3-inch bolt cutter that is shown in the accompanying photograph, and it is equipped with a Crocker-Wheeler motor and controller. A new and distinctive feature is found in the method of driving the spindle or shaft, the driving gear of which is located centrally between the bearings of the spindle instead of being at the extreme end thereof. A system of compound gearing makes it possible to obtain greater power without having an unduly large driving gear. This method of driving the head spindle eliminates all torsion and produces a smoother and more rapid cut without chatter.



Rear View of Electrically-driven Bolt Cutter.

The oil and chips which work through the hollow spindle are no longer a cause of trouble by falling upon the belt and pulley. The working parts are all easily accessible and the floor space has been reduced by the compact design of the machine. In the belt-driven machines, a four-step cone pulley replaces the gear that is shown in the cut meshing with the motor pinion.

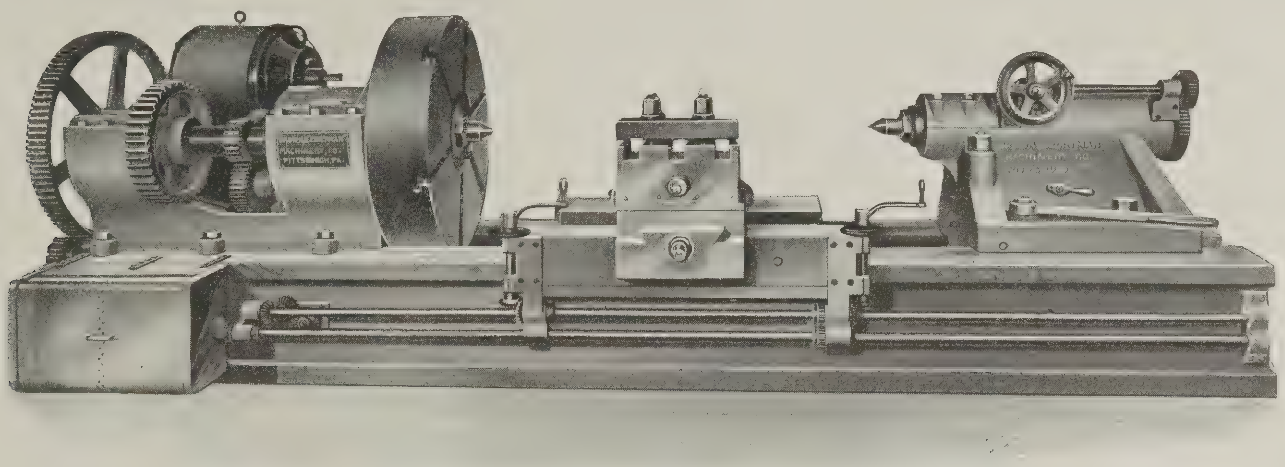
A NEW 42-INCH FORGE LATHE.

The Brown & Zortman Machinery Co., Pittsburg, Pa., have just placed on the market the new 42-inch forge lathe that is illustrated in the accompanying half-tone. This lathe is arranged to be driven by a 25-horse power variable speed motor or by a 4-inch belt running on a five-step cone pulley. Five speeds are thus available and by changing a gear on the end of the motor or cone shaft, five more speeds are obtained. The gearing is in the ratio of 1 to 84, and terminates in a broad internal gear in the faceplate by which the spindle is driven. A large and a small cathead are provided which are fastened to the faceplate and used in lieu of dogs for driving the work.

The tailstock is clamped to the bed by six binding bolts and is also provided with a latch which drops into a slot in the bed and thus keeps the tailstock from sliding back. A hand wheel and gear arrangement is provided to facilitate the movement of the tailspindle in and out of the tailstock.

The carriage has no hand movement along the bed but has three feeds, available by lever at the apron. These feeds can be changed from one to the other instantly while the machine is in operation. The feeds are .189, .354, .664 inch, and then by changing the gears .134, .251 and .469 inch per revolution of the spindle. Quick movement is furnished to the carriage when it is to be moved a considerable distance, and at other times the coarse feed is available. The feed is driven by gears in the headstock which in turn drive a screw, inside of the bed, running in a long, solid, bronze nut which is fastened to the carriage. This screw is supported in bearings planed into every cross tie in the bed and the thrust in either direction is taken upon large ball bearings. The carriage is furnished with an upper block that has three grooves for securing tools, 2½ × 3 inches, and which allows of a hand movement of the tool longitudinally. When the variable speed motor is used the carriage is provided with a controller lever by which any speed forward or backward can be obtained at once.

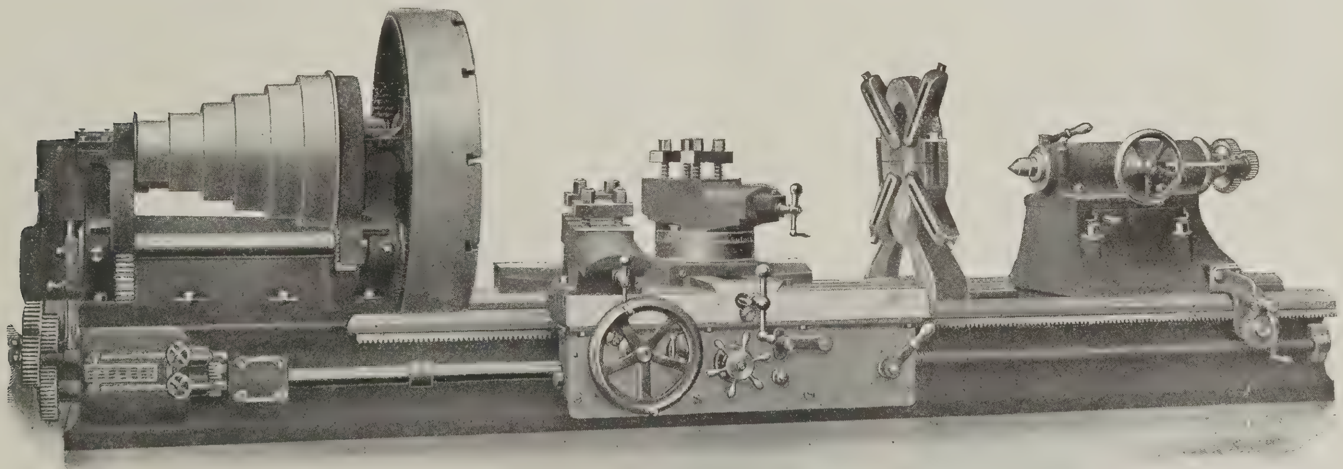
The lathe, when mounted upon a 20-foot bed, has a capacity of 10 feet between centers and weighs about 38,000 pounds. Any length of bed may be furnished, each additional 2 feet of length adding about 1,450 pounds to the total weight.



Brown & Zortman 42-inch Forge Lathe.

SIXTY-INCH "AMERICAN" SCREW-CUTTING LATHE.

The American Tool Works Co., Cincinnati, O., have just brought out the new 60-inch screw-cutting lathe illustrated in the accompanying half-tone. This tool is equipped with improved rapid change gear mechanism which greatly increases its capabilities as a rapid handler of heavy work. This mechanism is located on the head end of the bed and consists of a clutch device, of new design, through which seven changes for feeding and screw cutting are rapidly available without the removal of a gear. Then, by changing a single gear on the stud, seven additional changes are provided, the quadrant being so designed as to obviate the readjusting of the entire train of gears to each new change gear. Nine change gears are ordinarily furnished, thus providing a total of 63 changes of threads and feeds. Each of these changes is indicated on the index plate located on the front of the gear box. By the simple movement of a hand wheel, a pointer is brought directly above the desired thread or feed. This will indicate the number of the change gear that is to be placed on the stud and also automatically arrange the gears in the gear box for cutting any thread or feed desired. The range of threads is from one in eight inches to 16 per inch.



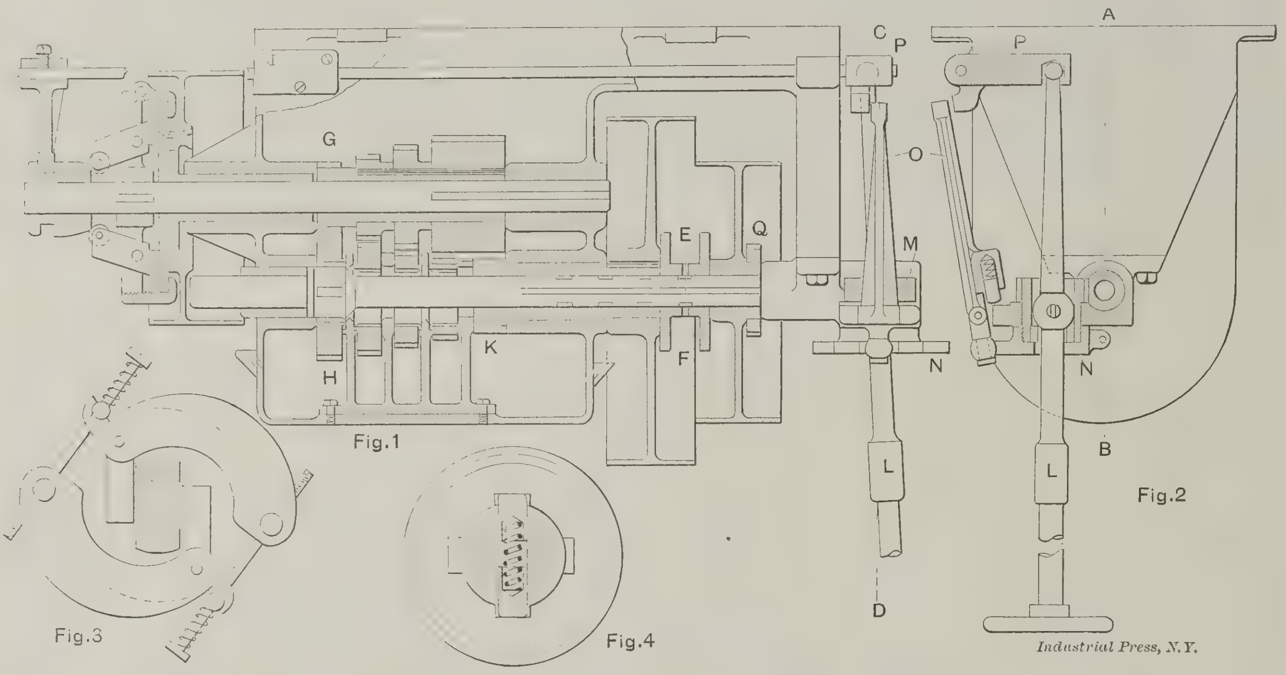
American Tool Works Co.'s 60-inch Screw-cutting Lathe.

The lathe can be arranged for left-hand screw cutting by means of a tumbler reverse plate which is mounted on the end of the headstock, so that it is not necessary to interpose an idler gear as formerly and no gears are ever disarranged by this method.

The bed is of drop V pattern, of such construction as to secure the greatest rigidity. The headstock is massive and the driving cone is mounted on a spindle of its own, entirely independent of the main spindle, and is powerfully geared. The carriage is very heavy, especially in the bridge, due to the drop V bed, and has double apron extending its full length. The compound rest is fitted with taper gibs and provided with power cross and angular feeds.

THE "SCHELLENBACH" VARIABLE SPEED PLANER COUNTERSHAFT.

While much has recently been accomplished in the development of the variable speed countershaft for use with machine tools in general, a countershaft for the exclusive use on planers, combining with variable speed drives a constant return and provision for elevating the cross rail, has, up to the present we believe, been lacking. The demand for such a countershaft has been met by the "Schellenbach" variable speed countershaft, illustrated by the accompanying drawings and half-tone photograph, which is the product of the National Machine Tool Co., Cincinnati, Ohio. This countershaft provides for four cutting speeds, ranging from 20 to 50 feet per minute and a constant return speed of 70 feet per minute.



Industrial Press, N.Y.

Figs. 1 to 4. Details of "Schellenbach" Variable Speed Countershaft.

Referring to the illustrations, the pulley shown at the left takes its power from the main line as in the ordinary countershaft. It is operated with the usual sliding bush and fork, engaged and disengaged by the shipper rod which passes entirely across the main frame and connects with the lever, at the lower end of which will be seen the handwheel by which it is moved back and forth. The method for obtaining the changes of speed will be understood by reference to the drawings, Figs. 1 to 4. The upper cone of gears is made of forged steel and is fitted as a unit for convenience in assembling. The largest gear of the upper cone meshes with a sleeve pinion, *K*, which passes through and takes its bearing in the casing. It has keyed to it the pulley which drives the return stroke of the planer platen. Thus it will be seen that the return speed is always constant and is not influenced by the four gears, with large bore, which rest in receptacles normally out of mesh with their mates above. These gears are keyseated, as is shown in Fig. 4, which is a section on the line *G H*, and receive the flat tool steel keys which are fitted into a slot cut through the enlargement of the lower shaft. These keys oppose each other with the aid of springs which are side by side. The casting, which supports the lower cone of gears, by their hubs which rest in counterbored receptacles, is bored to fit the enlargement of the lower shaft and serves to depress the keys as the enlarged portion containing them passes through. The lower shaft is splined to receive the smaller pulley which controls the cutting speeds.

Cut into the shaft are notches spaced to correspond with the gears which make the changes. The two pulleys, as shown in Fig. 1, are separated by a flange casting the inside of which on the line *E F*. The casting referred to is also splined to turn with the lower shaft and contains latches which mesh into the notches above referred to. Fig. 3, which is a section on *E F*, shows this centrifugal lock, which is a simple and sure means of making it impossible to mesh the gears when running at a high speed. The lever *L* is ball-seated into the gear *M*, and serves the purpose of revolving this gear as well as operating the friction pulley as before mentioned. The gear *M* has a cam *N* attached to it and this cam operates the lever *O* and forms a locking device which makes it necessary to release the friction pulley before a change of speed can be made, and if such change is only partly made the friction pulley cannot be connected. A glance at Figs. 1 and 2 will readily show how this is accomplished by means of the parts *N*, *O* and *P*.

The pulley *R*, in Fig. 5, is used for elevating the rail and is driven through a short shaft upon which is a gear that meshes with the gear *Q*, Fig. 1. This elevating pulley shaft may be extended to suit conditions and a regular hanger used to support it. The device throughout is provided with thorough facilities for oiling and a drip pan is cast on either end of the gear casing under the shafts to catch the oil and return it inside of the casing. The gears may run in an oil bath if preferred.

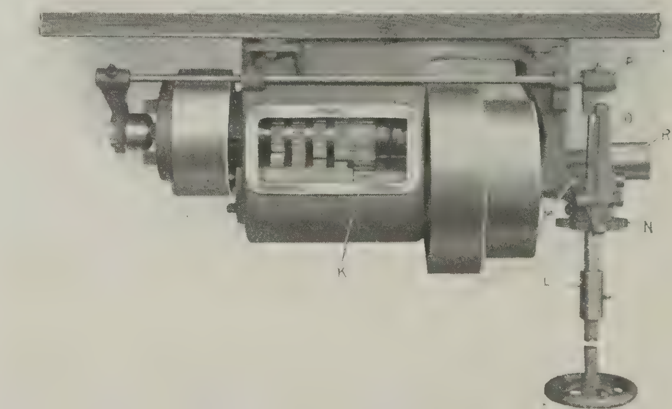
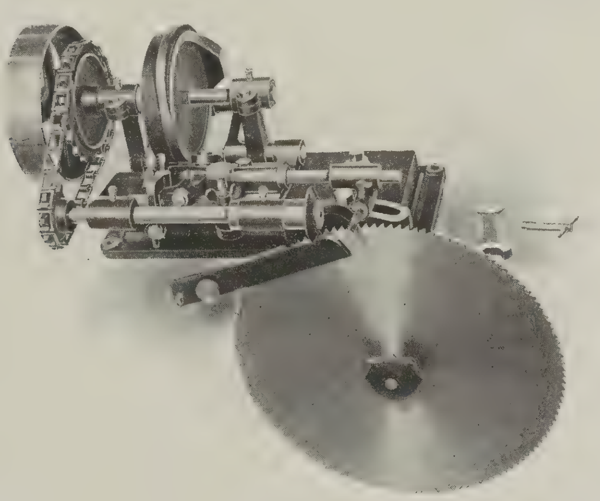


Fig. 5. "Schellenbach" Variable Speed Planer Countershaft.

When desired the friction driving pulley may be omitted and a coupling provided to receive a motor shaft, thus making a simple and direct method for using a constant speed motor.

AUTOMATIC SAW FILING MACHINE.

The accompanying cut illustrates a machine that is designed for truing up and filing circular, band and hand saws by power and thus obviating the tedious hand work ordinarily required for this purpose. The machine uses a rotary file about 2¼ inches in diameter, having a cross section suitable for the work. Two forms of file are usually required, the one for rip saws having an angle of 50 degrees, and that for cut-off saws having an angle of 60 degrees. The file is carried by a rocker arm, and a spacing gage, provided with hardened steel finger and adapted to drop into the tooth space, is also carried by a slide on the rocker arm. A cam motion is arranged to automatically lift the file clear of the teeth, move the gage forward, drop it into a tooth space, bring back the file to normal position and then drop it into the next tooth space. This space gage is normally held firmly into the tooth space by spring pressure and holds the saw against any longitudinal movement, while the file may be readily adjusted toward one side or the other of the tooth space if the latter is uneven. The guide clamp is provided to hold the saw blade and at the same time permit it to be readily slipped through.



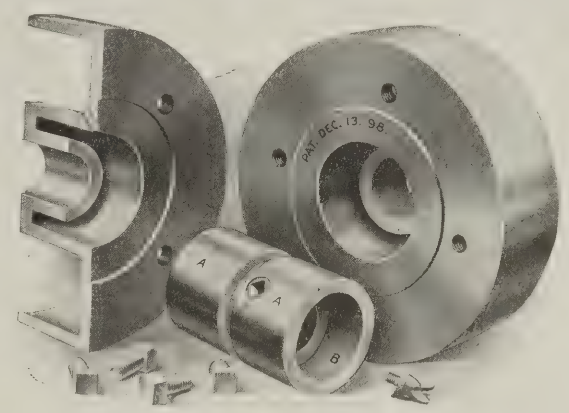
Automatic Saw Filing Machine.

To control the depth of cut of file an adjustable screw is provided in the rocker arm, allowing the latter to drop only to a predetermined distance and hence allowing the file to cut only to the desired depth. These two features, the spacing gage and the depth gage, make it possible to true up unevenly-filed or toothed saws, and once a saw is true it can be filed without further attention. Means are provided for setting the saw at any unusual angle of hook and at any bevel of teeth up to 30 degrees. Adjustment is also provided for varying the position of the file with reference to the spacing gage while the machine is in operation. This machine is adapted, by use of an interchangeable saw-carrier, for filing band saws and for hand saws. It has a capacity for filing circular saws up to 22 inches in diameter and ½-inch teeth, band saws up to ½-inch teeth and 1½-inch width of face. It will also file as large as 1-inch teeth on the points, when the gullet can be filed out at a separate operation. This machine is the product of the Rotary File & Machine Co., Brooklyn, N. Y.

THE "NELSON" LOOSE PULLEY.

Of all appliances used in connection with the running parts of machinery, none have been the source of greater annoyances than the loose pulley. On this account numerous devices have been produced to insure proper lubrication and prevent the pulley from sticking to the shaft. Most of these consist of a network of oil grooves, a multitude of drilled holes or the use of a bushing of wood, babbitt or other anti-friction material. The trouble with a great many of these devices is the lack of sufficient bearing surface for the hub of the pulley. While capillary attraction between the shaft and the sides of the bore of the pulley would naturally tend to preserve a thin film of oil entirely around the shaft, the load on the pulley produces so great a pressure per square inch of bearing surface that the film of oil is forced out and metal-to-metal contact ensues and causes trouble.

A loose pulley that is somewhat out of the ordinary construction and in which the above trouble has been obviated is the "Nelson" loose pulley, which is illustrated herewith. In this case the pulley does not run directly on the shaft but upon a sleeve or bushing, *A*, which is firmly clamped to the shaft by headless setscrews. This arrangement furnishes a large bearing surface for the hub of the pulley and thus reduces the pressure per square inch to such an extent that the film of oil continually surrounds the sleeve and permits the pulley to run upon the oil without any actual contact with the sleeve. Oil is held in an oil chamber formed in the bushing and from this reservoir it is thrown by the action of centrifugal force onto the bearing surface. The great advantage of this method of lubrication is, that as the speed of the pulley increases, and more lubricant is demanded, the centrifugal force likewise increases, thus adequately suiting the supply to the demand.

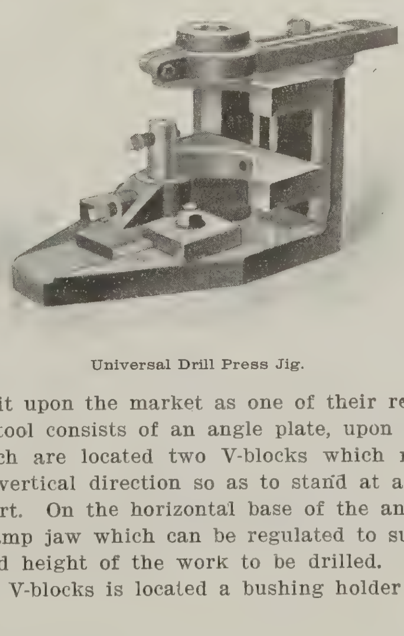


Details of the "Nelson" Loose Pulley.

The pulley is made in halves which fit over the bushing and their hubs, form a guard that is proof against dirt or dust from without and the escape of oil from within. A continual supply of clean oil is thus insured, and when once the reservoir has been filled the pulley may be run indefinitely without attention. To replenish the oil supply it is necessary only to remove a small thumb screw and fill the oil chamber from an oil can. These pulleys have been thoroughly tested for a period extending over five years and, having proved satisfactory, are now being placed upon the market by the Wilmarth & Morman Co., Grand Rapids, Mich.

UNIVERSAL DRILL PRESS JIG.

In view of the difficulty experienced in holding in an ordinary vise, cylindrical pieces such as pulleys, journals, cones, cams, etc., the Bayldon Machine & Tool Co., Jersey City, N. J., designed and constructed the drilling attachment here illustrated and so successful has it proved that they have now placed it upon the market as one of their regular products. This tool consists of an angle plate, upon the vertical side of which are located two V-blocks which may be adjusted in a vertical direction so as to stand at any required distance apart. On the horizontal base of the angle plate is a sliding clamp jaw which can be regulated to suit both the diameter and height of the work to be drilled.



Universal Drill Press Jig.

Above the V-blocks is located a bushing holder which may be moved in and out to accommodate varying diameters of work but always remains in line with the center of the V-blocks. This holder is for carrying steel bushings that act as a guide for the cutting tool, which may be a rose reamer, an ordinary twist drill, a four-lipped drill or a boring bar. Bushings can be furnished for any diameter of drill or bar up to 3½ inches in diameter. The capacity of this tool ranges from pieces 7 inches in diameter and 6½ in length, down to those 1½ in diameter and 1 inch long.

A NEW MILLING MACHINE FOR HEAVY WORK.

The Henry Hess Machine Co., Philadelphia, Pa., have just brought out a new type of slab milling machine that is especially adapted to all kinds of heavy work where it is desired to produce flat surfaces quickly and cheaply. This machine is capable of taking a cut equal to the greatest width between the housings, 30 inches, and carries cutters up to 15 inches in diameter. The platen, as ordinarily furnished, has a working capacity of 8 feet, and may be increased, if necessary, by increments of 2 feet. The cutter is driven by a worm of steep pitch which is, in turn, driven from a two-speed overhead countershaft with cone pulley. The cutter itself terminates at the driving end in a large flange, which is bolted to a corresponding flange upon the driving arbor. The drive is therefore from a diameter equal to or larger than the diameter of the cutter employed.

The outer end of the cutter is supported in a bracket mounted upon the same cross rail that carries the driving head, and when two pieces are being milled side by side an intermediate support is introduced between the two pieces of work. The cross rail may be raised or lowered by power and has micrometer adjustment for depth of cut. Provision is made for driving the spindle at eight speeds, from a minimum of 6 revolutions per minute to a maximum of 36. The platen has both hand and power feed, and a quick return by power. The rate of feed is controlled by a small hand-wheel, which is placed near the operator, and may be varied from .5 inch to 30 inches per minute, twelve changes being provided for. The net weight of this machine is about 52,000 pounds.

* * *

NEW TRADE LITERATURE.

The Ray Automatic Machine Co., Cleveland, O. Circulars treating of the "Vulcan" steel annealing box and "Vulcan" putty for annealing, with directions for using. Also folder treating of the manufacture of automobile parts such as hoods, fenders, radiators, tanks, mufflers, etc., with illustrations of same.

The Webster & Perks Tool Co., Springfield, O. Circular of grinding and polishing machinery. The 1-inch bench grinder, the 1¼-inch self-oiling bench grinder, the improved No. 1 and No. 2 self-oiling, buffing and polishing lathes, are shown. Also a 1-inch grinder on a pedestal.

Wm. Pilton, Hamilton, O. Descriptive circular of parallel ruler attachments, which may be attached to any form of drawing boards or tables, for office, school or home use. Also circulars describing an instantly adjusted drawing table, and a draftsman's new handy reference table.

Hammacher, Schlemmer & Co., New York. Catalogues Nos. 185, 187, 188 and 190. These are supplementary lists of the various classes of goods catalogued. The first of these treats of hand screws, bench screws, clamps, etc.; the second of wood carvers' tools and accessories; the third, of miter boxes, trimmers, etc.; and the last, of files and rasps.

The Ingersoll-Sergeant Drill Co., 26 Cortlandt Street, New York. New drill catalogue No. 43, the first of a series of catalogues which will illustrate and describe in very complete form all classes of Ingersoll-Sergeant machinery. The cuts and descriptive matter are nearly all new and the catalogue itself is an unusually handsome product.

The Loop-Lock Machine Co., Waltham, Mass. Price lists of the No. 2 bench and No. 3 special milling machines and attachments, and of No. 3 bench lathes and attachments. Also illustrated circulars of No. 2 bench milling machine, No. 3 automatic internal grinding machine and of No. 3 bench lathe, new model, and attachments for same.

The Etna Manufacturing Co., No. 253 Broadway, New York. Special illustrated circular describing their new clock spring-tempered back, hack saw blades. They state that the blades are manufactured by their new process, whereby the tooth edge only is left hard, while the back is drawn to a clock spring temper, permitting the saw to bend without kinking or breaking readily, and thereby giving the user full efficiency until the teeth are worn out.

The Peerless Rubber Mfg. Co., 16 Warren Street, New York. Catalogue No. 58 of "Peerless" spiral piston and valve rod packings. "Rainbow" packing is described, which is especially adapted for very high pressure, being vulcanized in a higher degree of heat than it ever comes in contact with in a joint. The "Eclipse" sectional rainbow gasket is also treated, as well as the different styles of packings for various purposes, and seamless rubber belting, steam hose, etc. This catalogue will be sent to any one upon application.

The Berlin Construction Co., Berlin, Conn. Catalogue 1903 giving 40 illustrations of steel-frame construction work done by this company. This includes machine rooms, factories, foundries, bridges, etc., and the cuts give an excellent idea of the great variety and good quality of the work done. A partial list of the company's customers also appears. The company have a complete modern structural steel plant, and their shops are operated throughout by electricity and compressed air. The branch offices are at New York, Boston, and Newark.

The North Penn Iron Co., North Penn Junction, Philadelphia, Pa. Bulletin "W" No. 705, treating of the steam locomotive cranes manufactured by this company. These cranes are useful in yards, as any irregular area can be covered with them, and they can be used as a locomotive for moving freight cars for transporting heavy work from one building to another. These steam cranes are especially useful in plants where electric power is not available. An illustration shows a 10-ton crane, with half cab or roof. Full cab can be furnished if desired. The cranes are made for standard track gage of 4 feet 8½ inches.

Pratt & Whitney Co., Hartford, Conn. Standard 6 x 9 booklet just issued of the company's bench lathe, 10-inch toolmakers' lathe, 13-inch engine lathe, and 14-inch gibbed carriage engine lathe. The book contains 67 pages and is fully illustrated with excellent half-tone plates. The first thirty-seven pages are taken up with a description of the 7 x 32-inch bench lathe, described in detail and illustrations are given of more than thirty of the various attachments which may be furnished with the lathe, giving an adequate idea of the great diversity of work for which this machine is adapted. The 10-inch toolmakers' lathe is also carefully described, and illustrations are given showing the application of the collets and split step chucks to the spindle. Two views of the 14-inch lathe show the standard lathe, and the lathe with pan bed. A number of important attachments for this lathe are also shown. These include the relieving attachment for relieving straight, taper and spiral taps and milling cutters, draw-back collets, step chucks and closers and expanding arbors. While these lathes perhaps are not applicable to rough shop use, anyone who cares for good machines or who has to do accurate work will appreciate them.

MANUFACTURERS' NOTES.

The foundry and machine business formerly conducted by the Robert Poole & Son Co. has been merged into the Poole Engineering & Machine Co., and will be continued under this corporate name.

The Ray Automatic Machine Co., formerly at Cleveland, O., have removed to corner Front Street and First Avenue, Berea, O., where they have increased facilities for manufacturing their line of automatic nut machines, cold punched nuts, etc. They state that the rates of freight from Berea are the same as from Cleveland.

E. Horton & Son Co., Windsor Locks, Conn., have recently completed an addition to their works which triples their capacity. They have installed a number of special machines and discarded all the old tools, bringing their plant up to date in every respect. The Horton Co. build a complete line of chucks, including every kind made.

The Springfield Tap & Die Co., Springfield, Vermont, have incorporated a number of features in their product which adds to its value. Their patent relief ensures excellent results, and their improved method for threading does away with many of the inaccuracies which taps have heretofore been subject to. Their sizes are guaranteed to run uniform, which is a feature that every mechanic will appreciate.

The Brown & Zortman Machinery Co., Pittsburg, Pa., have opened an office and store room at the Bourse, Philadelphia, under the charge of R. G. English, where they will be glad to see all their Eastern friends. They will have constantly on the floor both Colburn boring and turning mills and Universal saw tables, as well as a full line of modern machine tools of standard manufacture.

The D. E. Whiton Machine Co., New London, Conn., have just completed a new foundry, 60 x 100, which will add greatly to their facilities. The building adjoins their works and is high and well lighted, and will be equipped with all the modern foundry appliances. They have also built a four-story L-shaped addition to their works, 80 x 85, extending along the railroad track and giving them unexcelled facilities for receiving and shipping goods.

The Abrasive Material Co., of Philadelphia, have made two more additions to their already extensive plant—another new kiln, and a recent installation of new machinery for making their pressed emery wheels. The present abrasive emery wheel is made by the vitrified process, and by reason of its fast, free cut has given great satisfaction in all classes of grinding. The makers, however, realize the need of special wheels for special purposes, and have decided to place on the market a pressed wheel that will, for its special work, equal those made by the vitrified process.

The Ingersoll-Sergeant Drill Co., 26 Cortlandt Street, New York, who have placed a line of pneumatic tools on the market, report immediate recognition of the excellence of the Haeseler "Axial Valve" hammers, upon comparative tests with other tools. Among the latest purchases of these tools are: Niles-Bement-Pond Co., Ramapo Iron Works, MacPherson Switch & Frog Co., Creswell & Waters Co., Warren Foundry and Machine Works, Chicago, Rock Island & Pacific R. R.; Brown Hoisting and Conveying Machine Co., Howard Iron Works, International Boiler Works Co.

Roth Bros. & Co., manufacturers of dynamos and motors, have recently moved to 27-29 So. Clinton Street, Chicago, Ill., where they have more than doubled their floor space and have added machinery for the more efficient handling of their work. They have fitted all their machines with individual motor drive. Some have the motor directly connected while others have single belts—the lathes for instance, which are driven by their electric countershafts, or motors with a back-geared shaft upon which is mounted the cone pulley. The controller, of the reversible style, is also hung from the ceiling and operated by a rod connecting with a splined shaft on the lathe, which rod is in turn operated by a handle which travels with the lathe carriage. Coarse changes of speed are obtained by shifting the belt, and intermediate speeds, through the controller.

The Standard Welding Co., Cleveland, O., inform us that a very interesting test has recently been made, at a large bicycle factory, of two bicycles—one built entirely of seamless tubing made by the Standard Welding Co., and the other, with ordinary seamless tubing. The wheels were put to test on a vibrating machine with the result that the bicycle of ordinary tubing went to pieces after a continuous run of only 36 hours, while the bicycle built with the "Standard" seamless tubing stood up over 72 hours, thereby demonstrating its strength to be twice as great as that of the cold-drawn tubing. The "Standard" tubing is made from stock of uniform thickness, and the welding, which is done by electricity, makes every section of the tube of equal strength, and the product much more uniform than is possible with the cold-drawn tubing.

Thos. H. Dallett & Co., Philadelphia, Pa., have lately been reorganized and incorporated as the Thos. H. Dallett Co., with officers as follows: President, Thos. H. Dallett; Vice-President and General Manager, Ernest C. Bliss; Secretary and Treasurer, E. C. Clay. W. H. Van Sickel, lately New York representative of the Under-Feed Stoker Co., of America, and formerly identified with the pneumatic tool industry, is Superintendent. The company will greatly extend and enlarge the capacity of their plant, located at York Street and Sedgley Avenue, and while continuing the manufacture of their well-known belt and electrically driven portable drills, deck planers, etc., will devote especial attention to the production of "Dallett" pneumatic tools. Their works are equipped with the latest and most improved machinery.

MACHINERY.

October, 1903.

A SCREW PROPELLER PLANING MACHINE.

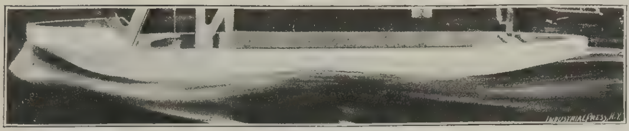


Fig. 1. Model of a Ship's Hull under Test.

THE machine of which an illustrated description is published herewith, is entirely novel in conception and design and in the work that it performs. It was designed for planing the blades of screw propellers, to be used for experimental purposes, and will accurately finish helicoidal surfaces of any desired pitch, within reasonable limits and with the pitch either uniform or variable. The machine was built for the United States Government by the Builders Iron Foundry, Providence, R. I., and is now in use at the Washington, D. C., Navy Yard as an adjunct of the experimental model-testing basin located there, where models of vessels are tested to determine their performance at various speeds.

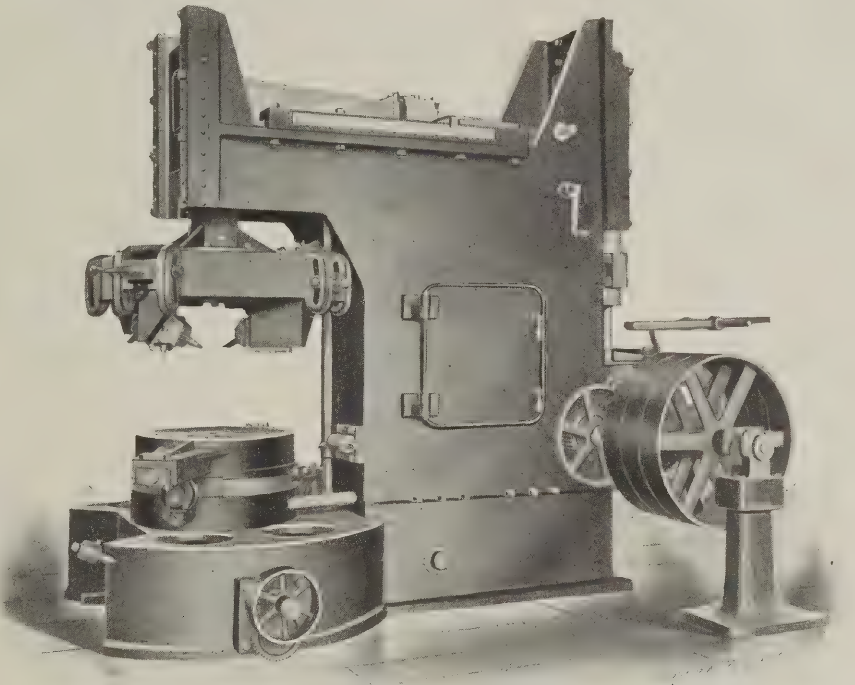


Fig. 2. Propeller Planer for Machining the Blades of Propellers for Experimental Purposes.

The experimental model basin was completed between two and three years ago, and tests upon models of ships of various types have since been regularly conducted. The building in which the basin is located is 500 feet long, and 50 feet wide, while the water surface of the tank is 470 feet long. The basin is spanned by a bridge which travels on carefully leveled tracks at the side of the basin and is driven by electric motors fitted with the Ward Leonard system of control, which permits an almost infinite variety of very uniform speeds. The model to be tested is placed in the water below the bridge and attached by a flexible connection to brackets extending below the bridge. The brackets support a dynamometric apparatus by which the resistance of the model is automatically recorded upon a drum placed on the platform above for the different speeds at which it is towed. The models are made uniformly 20 feet long and coated with smooth, white enamel. The process of making the models involves the use of several complicated special woodworking machines. As a result of one of the first series of tests changes were made in the lines of a model which were such an improvement that had the vessel been constructed along the old lines instead of in conformity with the new, it is estimated it would have required 2,000 horse power more to have propelled it at its maximum speed of 19 knots an hour than was required with the vessel as constructed.

The propeller models which the planing machine was built to produce are to be tested in connection with ship models in the experimental basin. Tests upon screw propellers have previously been conducted, either with full-sized propellers on full-sized ships—which is at best a slow and very expensive process—or with small propellers made to rotate in a fixed position in a tank of water, and driven by an electric motor or other power outside of the tank. Tests of the latter description have recently been carried on at the naval academy at Annapolis, and have been productive of good results, although the information to be derived from them is necessarily comparative rather than specific. Results that will supply definite data for a designer to work with can only be obtained by testing a propeller in connection with the hull of a ship, where there is always motion of the water around the stern, relative to the hull, which affects the action of both ship and propeller. It is proposed to test the propellers made on the planing machine by equipping a model hull with them and driving the propellers with electric motors, which will enable the power absorbed and the speed of rotation to be accurately determined; and from the results derived from such tests the performance to be expected from propellers and hulls on similar lines, but of full size, can be closely calculated.

The general features of design of the planer were outlined by the Navy Department and were original with Naval Constructor D. W. Taylor. The details of construction, however, were left with the builders and were worked out by Mr. F. N. Connet, mechanical engineer of the Builders Iron Foundry. The planer operates on rough bronze propeller castings of two, three or four blades, ranging from five inches to 24 inches in diameter and will finish both the fronts and backs of the

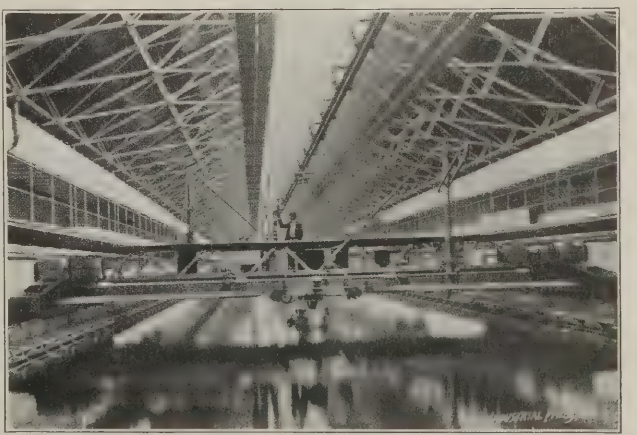


Fig. 3. The Marine Experimental Basin, Washington Navy Yard, where Screw Propellers are to be Tested.

blades. The cutting is accomplished by diamond-point or round-nose tools, the tools and work being given such relative motion as to cause the surface of the blade to have the required pitch and form. The propeller is mounted, with its axis vertical, upon a horizontal table, which has a reciprocating rotary motion about its vertical axis. The cutting tools are carried by a cutter head, which has a reciprocating motion in a vertical direction, timed to correspond with the motion of the table. Provision is made for varying the extent of the travel of the cutter head, relative to the motion of the table, by this means varying the pitch of the surface being planed. The machine is driven by a shifting-belt mechanism, similar to a planer of the usual type, the shifting mechanism, in this case, being controlled by dogs clamped in a T-slot on the periphery of the table. Both the cutter head and the table are operated by the same shifting belt, and the feed for the tools is operated by a planer feed mechanism, with friction clutch.

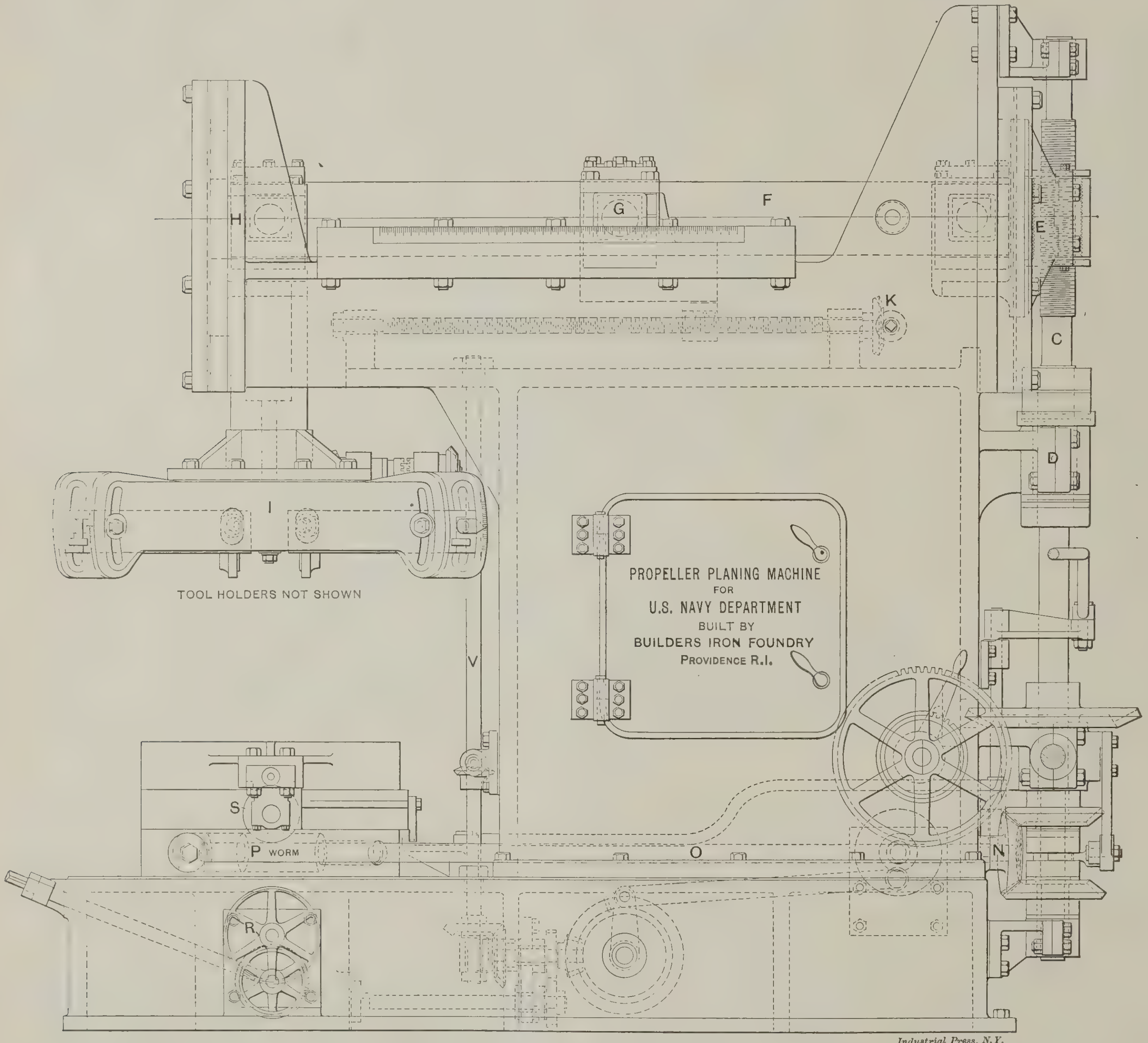


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Fig. 4. Side Elevation of Propeller Planer.

In Fig. 2 on the first page is a side view of the machine and in Fig. 4 is a side elevation indicating many details of construction. The two subsequent views, Figs. 5 and 6, show details of the mechanism at the rear of the column and on the opposite side from Figs. 2 and 4. The belt pulleys are three in number, 30 inches diameter and 5-inch face, the two outside pulleys being loose and the middle one, *A*, in Fig. 6, is tight on its shaft and transmits motion through the bevel gears, *BB*, to the vertical driving shaft, *C*. This shaft consequently changes its direction of rotation with each reversal of pulley *A*, and the reciprocating motions of both cutter head and table are derived from it.

At the lower end of the driving shaft are bevel gears, *L* and *M*, Fig. 6, loose on the shaft, but either of which may be set in motion by a clutch which is splined to the shaft. These gears mesh with a third bevel gear, *N*, Fig. 4, and transmit motion through the shaft, *O*, to a worm, *P*, and worm-wheel, which drive the table, and give it its reciprocating motion. The object of the two bevel gears and clutch on the driving shaft is to reverse the direction of rotation of the table, relative to the motion of the driving shaft, so that either right- or left-hand propellers may be planed.

At the upper end of the driving shaft is a double-threaded screw, 3½ inches diameter, ¾ inch lead, which runs in an adjustable bronze nut, forming part of the crosshead, *E*. This crosshead is connected with the walking beam, *F*, Fig. 4, by a sliding and pivoted joint, and the walking beam, at its opposite end, is similarly connected with another crosshead carrying the tool head *I*. It is evident that in the production of the surfaces of a propeller blade the motions of the blade and tool are entirely analogous to the motions of the corresponding parts when thread cutting in a lathe. That is, for a propeller of uniform pitch, the propeller must rotate uniformly and the tool must advance uniformly, just as the work turns uniformly and the carriage and tool post advance uniformly in the case of the engine lathe. In the propeller planer the driving shaft has a uniform rotary reciprocating motion, received from the driving belt, as we have already seen, and this is reproduced in the motion of the table through the bevel-and-worm-gear connections. The design of the walking beam, also, is such as to give a uniform advance and return to the cutter head, this being accomplished by the crosshead at each end, guided in a straight, vertical line, in connection with the walking beam, which is so arranged that each end slides in a block pivoted to the crosshead at that end. This arrangement maintains a constant ratio between the lengths of the two arms of the walking beam, whatever the angle of inclination, and the motion of the cutter head thus accurately reproduces the motion transmitted by the screw at the upper end of the driving shaft, *C*.

The walking beam is a steel forging of rectangular cross section and has an adjustable fulcrum consisting of a trunnion block which can be clamped to the walking beam at any desired position along its length. This block has two trunnions supported in boxes carried by a casting which can be adjusted to any desired position by means of a crank, *K*, Fig. 4, a pair of bevel gears, and a screw. The adjustment of the position of the fulcrum varies the distance traveled by the cutter head, *I*, for each inch of travel of crosshead, *E*; and as the travel of crosshead *E* is always relatively the same as the travel of the table, it is evident that adjustment of position of the fulcrum of the walking beam enables propellers of various pitches to be planed. To facilitate setting the machine, the frame adjacent to the walking beam is graduated and indicates where the fulcrum must be set to correctly plane a propeller of given pitch. The maximum movement of crosshead *E* is 8 inches and the movement of the cutter head can be varied from 1 inch to 12 inches.

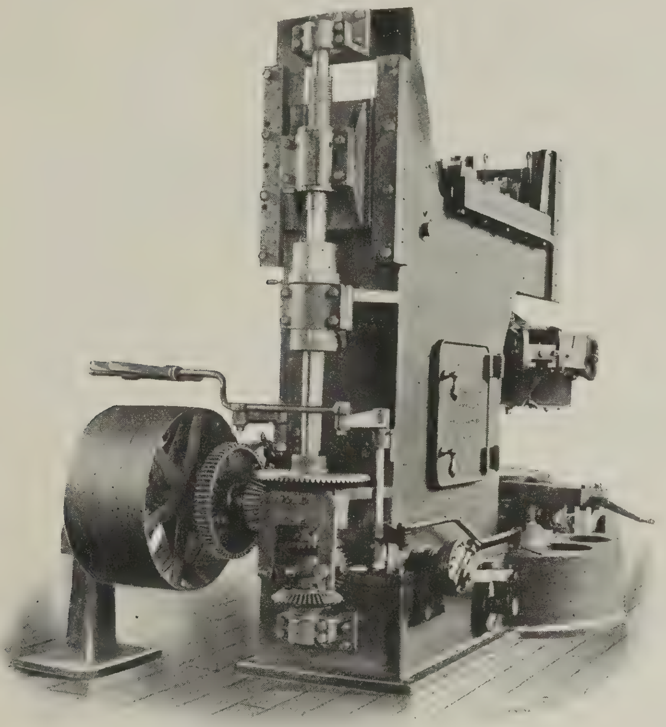

Fig. 5. View showing Feed and Driving Mechanisms.

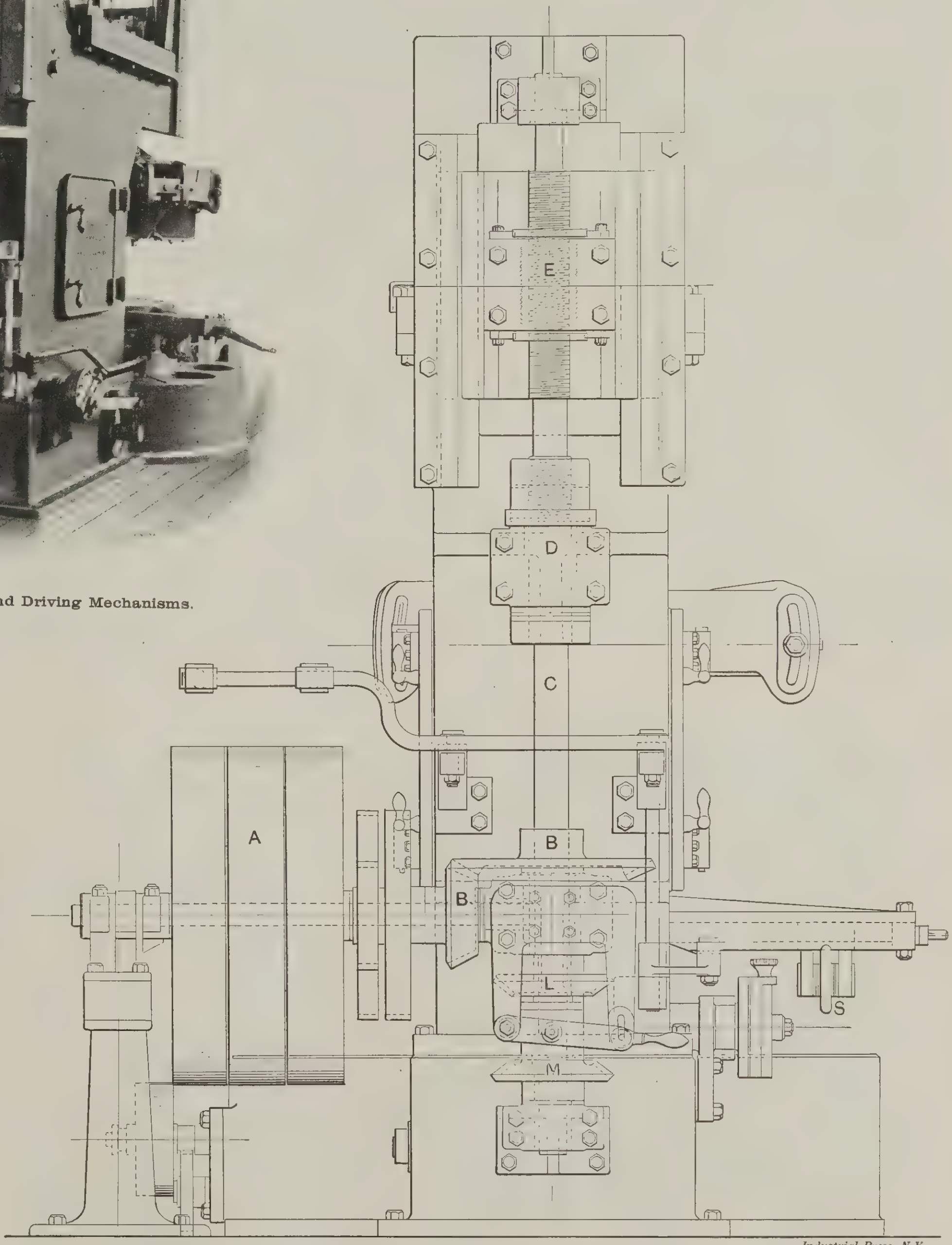

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Fig. 6. Rear Elevation of Propeller Planer.

The work table of the machine is 27 inches in diameter and is arranged so that it can be raised or lowered either by hand or by power, to bring the work into position for machining. The gearing for this purpose is shown at *R*, in Fig. 4. Provision is also made for the automatic lifting of the table while the machine is in operation, through the use of two cam surfaces, bolted to the base of the machine, on diametrically opposite sides of the table. By raising the table during the downward, or cutting stroke of the tool, the effect is the same as though the cutting speed of the tool were changed, thus allowing the propeller to rotate a greater or less amount, according to the shape of the cam, for every inch of travel of the tool, and producing a propeller of variable pitch. By laying out suitable cams any desired variation in pitch can thus be obtained. There are two horizontal arms, extending radially outward from the table, as shown clearly in the half-tone illustrations, each of which carries a sliding block supporting a steel roll. These rolls ride up and down on the cam surfaces as the table reciprocates, alternately raising and lowering the table. Provision is made for feeding the rolls out or in along the radial arms, their motion keeping pace with the out or in feed of the cutting tools; and by making the cam with a surface of changing curvature, different pitches can be employed for the inner and outer ends of the propeller blades.

In Fig. 7 is a view of the under side of one of the cutter heads. This head has four radial slots or channels, in each of which are slides or ways that carry the tool heads. The cutter head is designed for planing either two- or four-bladed propellers, and there is a second head having three radial slots spaced 60 degrees apart, for planing three-bladed propellers. The specifications for the machine called for the feeding of the tools in a radial direction in a horizontal plane, and also the ways on which the tool heads traveled should be capable of being swiveled up to 10 degrees in either direction with the horizontal, the object being to provide for propellers having "rake" to the blades. The slides are pivoted at their inner ends and are clamped in position by two bolts at their outer ends. Each tool head carries a tool post attached to a swiveling apron, similar to the tool heads of planers and shapers, and two sets are furnished, one right-hand and one left-hand, for cutting right- and left-hand screws, and all of them have adjusting screws for vertical adjustment of the tools.

The feeds for the tool heads are derived from a central stud gearing with feed screws which extend radially one for each slide. The feed screws have universal joints at their inner ends to allow motion to be transmitted when the slides are tilted above or below the horizontal. The central feed stud derives its motion from the bevel gear seen on the outside of the cutter head at top of the engraving, Fig. 7, and this gear in turn meshes with a gear on the splined feed shaft, *V*, in Fig. 4. At the lower part of Fig. 4, the gearing connecting this feed shaft with the ratchet wheel operated by the friction feed mechanism of the planer is shown by dotted lines. The cam rollers on the table arms also derive their feed motion from the same device.

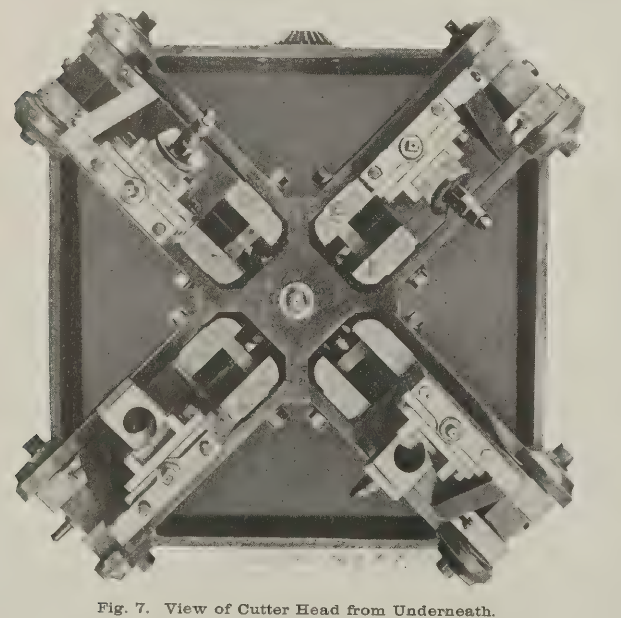

Fig. 7. View of Cutter Head from Underneath.

The machine is back-geared and is belted to a countershaft driven by an electric motor. It weighs about 10 tons, is 8 feet 10 inches high, 4 feet 10 inches wide, and 8 feet 3 inches long. It works to the entire satisfaction of the government officials and the builders.

Without doubt the installation of the propeller planer will result in the carrying out of many important and much-needed experiments upon screw propellers, and apparently we have started upon an era of scientific investigation in marine propulsion, and problems connected with it, which will give designers much better data to work with than any which now exist.

THE NEW SPRINGFIELD RIFLE, ADOPTED BY THE UNITED STATES GOVERNMENT.

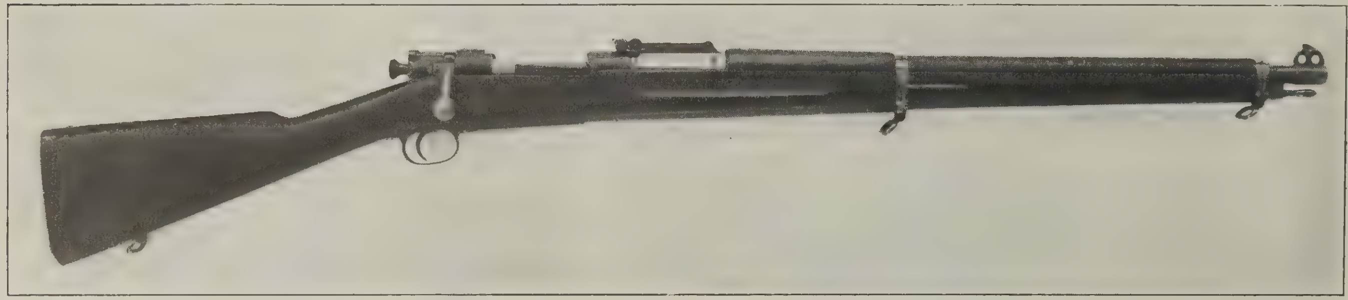

Fig. 1. The New Springfield Rifle—the best Army Rifle in the World.

The new Springfield rifle, model 1903, which has been adopted by the United States Government in place of the Krag-Jorgensen rifle, is a shoulder arm that, to date, is said to be without an equal in flatness of trajectory and penetrating power. Shooting at a range of 1,000 yards the maximum ordinate of the trajectory is only 20.67 inches high. That is to say, in a distance of 3,000 feet the parabolic path of the bullet curves upward less than 21 inches above the straight line connecting the muzzle and the point of impact. The initial velocity of 2,300 feet per second gives the projectile a penetration of 54.7 inches of white pine, the target being composed of 1-inch boards, 1 inch apart and located 53 feet from the muzzle. Since the energy required to penetrate the fleshy part of a man's body is about equal to that required to penetrate a 1-inch pine board, it follows that the new rifle theoretically has the power to mow down fifty-five men in a line at a distance of 53 feet from the muzzle.

The accompanying comparative table from the *Scientific American* gives the principal data for the new rifle, the Krag-Jorgensen which it displaces, the Mauser, and the German military rifle. The weight of the new weapon is 1.17 pounds less than that of the Krag-Jorgensen, but perhaps the greatest advantage is its short length, being only 43 inches as compared with 49 inches, the length of the latter. This length, which is slightly greater than that of a military carbine, will enable the arm to be used by both the cavalry and infantry, and it is expected that it will be adopted by the Navy Department as well, thus equipping all branches of the service with the same weapon and using the same ammunition.

NEW SPRINGFIELD MAGAZINE RIFLE COMPARED WITH THE KRAG-JORGENSEN, THE MAUSER, AND THE GERMAN MILITARY RIFLE.

	Springfield Magazine Rifle.	Service Magazine Rifle.	Mauser 7 mm. Rifle.	German Military Rifle.
Caliber, inches	0.30	0.30	0.275	0.311
Rifling: Number of grooves.	4	4	4	4
Rifling: Depth of grooves. inch.	0.004	0.004	0.0049	0.004
Rifling: Twist, one turn in, inches	10	10	8.66	9.45
Weight of bullet, grains	220	220	173	226.82
Weight of charge, grains	40.3	37.6	38.58	41.2
Weight of complete cartridge, grains	451.15	438.85	385.63	430.24
Initial velocity, feet per second	2300	2000	2200	2145
Remaining velocity at 1,000 yards	958	901	895	906
Muzzle energy, foot-pounds.	2581.6	1952	1857.4	2135
Striking energy at 1,000 yards, foot-pounds	447.9	396.2	307.4	413
Penetration in white pine at 53 feet, inches	54.7	45.8	50.8	..
Weight of rifle, including bayonet and scabbard, pounds	9.47	10.64	10.5	11.54
Weight of rifle, including bayonet, scabbard and 100 cartridges, pounds	15.91	16.91	16.8	17.68
Capacity of magazine, pounds	5	5	5	5
Maximum ordinate of 1,000 yards trajectory, feet.	20.67	25.8	24.47	23.73

Because of the general use of smokeless powder which has not only greatly widened the danger zone, but made close encounters practically impossible, the evolution of the military rifle will undoubtedly eventually end with the total discarding of the bayonet; in this gun it is reduced to a mere pike or rod bayonet. This rod normally lies underneath the barrel in the position ordinarily occupied by a cleaning rod or the ramrod of the old muzzle-loader. When required for action the rod bayonet is pulled part way out until a catch engages a circumferential groove.

The magazine holds five cartridges. Loading the magazine is effected by means of a clip holding five cartridges in a row, which is over the magazine with the breech open. Pressure downward forces the cartridges into the magazine where they

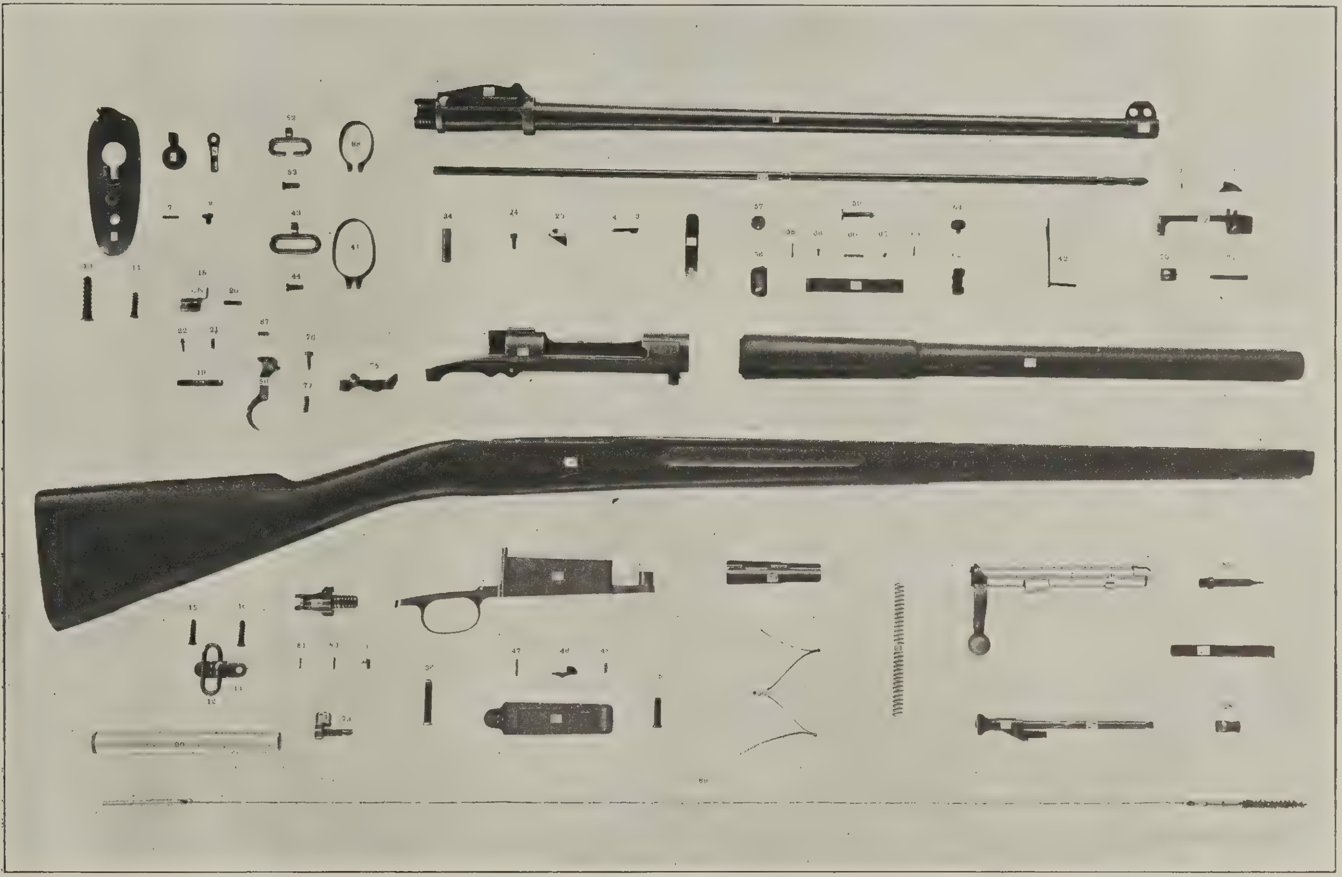

FIG. 2. COMPONENT PARTS OF SPRINGFIELD MAGAZINE RIFLE, MODEL 1903.

1. Barrel.
2. Bolt.
3. Bolt Stop Spring.
4. Bolt Stop Pin.
5. Butt Plate.
6. Butt Plate Cap.
7. Butt Plate Cap Pin.
8. Butt Plate Cap Spring.
9. Butt Plate Cap Spring Screw.
10. Butt Plate Screw—large.
11. Butt Plate Screw—small.
12. Butt Swivel.
13. Butt Swivel Pin.
14. Butt Swivel Plate.
15-16. Butt Swivel Plate Screws—two.
17. Cocking Piece.
18. Cut-off.
19. Cut-off Spindle.
20. Cut-off Spindle Screw.
21. Cut-off Spring.
22. Cut-off Spring Spindle.
23. Ejector.
24. Ejector Pin.
25. Extractor.
26. Extractor Collar.
27. Firing Pin.
28. Firing Pin Sleeve.
29. Follower.
30. Front Sight.
31. Front Sight Pin.
32. Front Sight Stud.
33. Front Sight Stud Pin.
34. Guard Screw, Bushing.
35. Guard Screw, Front.
36. Guard Screw, Rear.
37. Hand Guard.
38. Hand Guard Spring.
39-40. Hand Guard Rivets—two.
41. Lower Band.
42. Lower Band Spring.
43. Lower Band Swivel.
44. Lower Band Swivel Screw.
45. Floor Plate.
46. Floor Plate Catch.
47. Floor Plate Catch Pin.
48. Floor Plate Catch Spring.
49. Guard.
50. Magazine Spring.
51. Main Spring.
52. Base.
54. Base Pin.
55. Base Spring.
56. Eye Piece.
57. Eye Piece Knob.
58. Eye Piece Knob Pin.
59. Eye Piece Screw.
60. Joint Pin.
61. Leaf.
62. Slide.
63. Slide Pin.
64. Slide Screw.
65. Slide Spring.
66. Slide Spring Plunger
67. Slide Shoe.
68. Receiver.
69. Rod Bayonet.
70. Rod Bayonet Catch.
71. Rod Bayonet Catch Spring.
72. Rod Bayonet Stud.
73. Safety Lock Spindle.
74. Safety Lock Thumb Piece.
75. Sear.
76. Sear Joint Pin.
77. Sear Spring.
78. Sleeve.
79. Sleeve Lock.
80. Sleeve Lock Pin.
81. Sleeve Lock Spring.
82. Stacking Swivel.
83. Stacking Swivel Screw.
84. Stock.
85. Striker.
86. Trigger.
87. Trigger Pin.
88. Upper Band.
89. Thong.
90. Thong Case and Oiler.

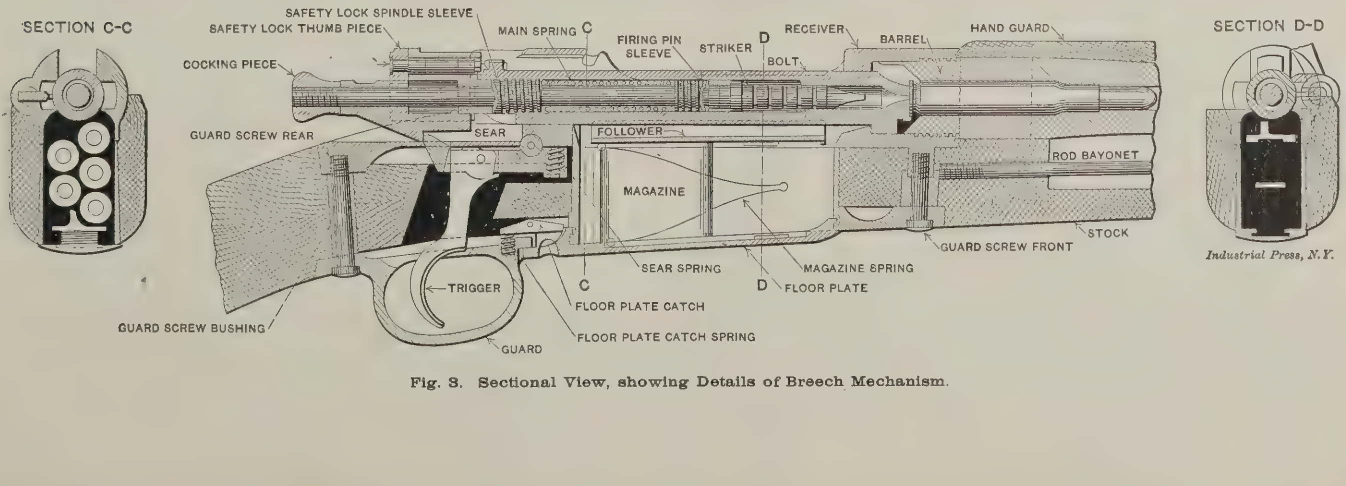

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Fig. 3. Sectional View, showing Details of Breech Mechanism.

take the position shown in the cross section view at the left of Fig. 3. The clip is discarded when the filling of the magazine is completed, the forward movement of the bolt throwing it to the ground. The gun can be used as a single-loader by cutting off the magazine.

The construction is simple and strong. Two lugs are provided on the bolt, instead of one, to resist the breech pressure. The location of the magazine does not impair the balance of the arm, and, being entirely concealed, it does not detract from the appearance. In fact the lines of the new gun are nearly as pleasing to the eye as those of some sporting rifles. The barrel is only 24 inches long and is entirely incased in a wood sheath, the object of which is to prevent the heating of the barrel, due to rapid firing, interfering with the handling of the piece. The uniform protection of the barrel also prevents unequal radiation and consequent deflection of the barrel which would result in inaccurate shooting. The barrels are turned so as to make the exterior perfectly concentric with the bore, and the seating of the barrel in frame is a detail that has been carefully worked out. Further description need not be given here, but suffice it to state that the details of design and manufacture have been planned with the view, so far as possible, of obtaining the maximum accuracy and efficiency in one type of weapon that shall be adapted to all branches of military and naval service. The new gun is to be manufactured at the government arsenals at Springfield, Mass., and at Rock Island, Ill., for the present at the rate of about 350 per day.

* * *

A STUDY OF ALLOYS SUITABLE FOR BEARING PURPOSES.

In an elaborate article, in the *Journal of the Franklin Institute* for July, Mr. G. H. Clamer discusses the advantages and disadvantages of various compositions and alloys for bearings, and especially alloys for railway journal brasses. He also quotes the results of many tests on various compositions made on an Olsen testing machine designed by Prof. Carpenter of Cornell University.

Upon close examination we find that there are but few metals available for bearings. They are copper, tin, lead, zinc and antimony. While other metals may be introduced in greater or less proportions, the five mentioned must constitute the basis for the so-called anti-friction alloys. The combinations of these metals now used may be grouped under the two heads of white metal and bronze. Bronze is the term which was originally applied to alloys of copper and tin as distinguished from alloys of copper and zinc; but gradually the term "bronze" has become applied to nearly all copper alloys containing not only tin, but lead, zinc, etc., and no sharp lines of demarcation exist between the two.

White metals are made up of various combinations of lead, antimony, tin, copper and zinc, and may contain as few as two elements, or all five. Bronzes are made up of combinations of copper, tin, lead and zinc, all of them containing copper and one or more of the other elements. The essential characteristics to be considered in any alloy for bearings are composition, structure, friction, temperature of running, wear on bearing, wear on journal, compressive strength, and cost.

It is utterly impossible to have one alloy reach the pinnacle of perfection in all the above requirements, and so it is important to study the possible compositions and determine for what purpose each is adapted. It has been shown that a bearing should be made up of at least two structural elements, one hard constituent to support the load and one soft constituent to act as a plastic support for the harder grains. Generally speaking, the harder the surfaces in contact the lower the coefficient of friction and the higher the pressure under which "gripment" takes place. It would seem for this reason that the harder the alloy the better; and it was with this idea in mind that the alloys of copper and tin were so extensively used in the early days of railroading. A hard, unyielding alloy for successful operation must, however, be in perfect adjustment, a state of affairs unattainable in the operation of rolling stock. For this reason the lead-lined bearing was introduced and the practice of lining bearings has now become almost universal in this country.

While the harder the metals in contact the less the friction, there will also be the greater liability of heating, because of the lack of plasticity, or ability to mold itself to conform to the shape of the journal. A hard, unyielding metal will cause the concentration of the load upon a few high spots and so cause an abnormal pressure per square inch on such areas, and produce rapid abrasion and heating.

The bronzes will, generally speaking, operate with less heat than softer compositions, while the softer metals will wear longer than the harder metals. In the matter of wear of journal, however, the soft metals are more destructive. Particles of grit and steel seem to become imbedded in the softer metal, causing it to act upon the harder metal of the journal like a lap. High-priced compositions are being used that have but little resistance to wear compared with cheaper compositions, and low-priced alloys are in service that are not cheap at any price. It is generally conceded that soft metal bearings cause a marked decrease in the life of the journal, and yet they have many marked advantages, as we shall presently see.

Bearings Containing Antimony.

Lead and antimony: These metals will alloy in any proportion. With increase in antimony the alloy becomes harder and more brittle. It has been determined that when this is made of 13 parts antimony and 87 parts lead the composition will be of homogeneous structure. If there is a greater proportion of antimony, free crystals of antimony appear, imbedded in the composition; and if less than 13 per cent. there appear to be grains of the mixture itself imbedded in the lead as the body substance.

According to one writer an anti-frictional alloy should consist of hard grains, to carry the load, which are imbedded in a matrix of plastic material, to enable it to mold itself to the journal without undue heating. Such a condition would be met in a lead and antimony alloy having above 13 per cent. antimony; but it is not advisable to use in any case more than 25 per cent. antimony, as the composition would be too brittle. The same writer claims that alloys having from 15 to 25 per cent. antimony are the best adapted for bearings. The author of the paper under review, however, does not agree with this, and says that alloys containing below 13 per cent. antimony can likewise be said to consist of hard grains consisting of the composition itself, imbedded in the softer material, lead, as mentioned above. He says: It has been my experience that, although the friction may be higher in such alloys, the wear is greatly diminished, and where pressures are light, causing no deformation, this is a great advantage. I have seen many instances in service where alloys between 15 per cent. and 25 per cent. were greatly inferior to alloys between 8 per cent. and 12 per cent., owing to their frequent renewal due to wear. It will perhaps be interesting to hear that the Pennsylvania Railroad Company, at the suggestion of Dr. Dudley, their chemist, have adopted the 13 per cent. antimonial lead alloy as a filling metal for bearings in order to obtain the best results.

In a general way my own work in the subject has confirmed the opinion that lead is the best wear-resisting metal known, and that with increasing antimony, or increasing hardness and brittleness, the wear becomes more marked. This is due to the splitting up of the harder particles.

The friction, as we may naturally expect, becomes less with increase of antimony, and the temperature of running likewise diminished when running under normal conditions; but the harder the alloy, the more difficulty is experienced in bringing it primarily to a perfect bearing, and the greater the liability of heating through aggravated conditions. The wear on the journal one would naturally expect to be decreased with increasing hardness; but this journal wear is in all probability not due so much to the alloy directly as it is to the fact that the softer metals collect grit, principally from the small particles of steel from the worn journal, and, acting as a lap, cause rapid wear. With the harder metals these particles are worked out without becoming imbedded.

The cost of the lead and antimony alloy is the least which can be produced. It can be used in many services where higher-priced alloys are being relied upon mainly for their high cost. It is one of the greatest extravagances of large industrial establishments to use materials that are too good for certain uses, and even perhaps unsuited, under the supposition that they must be good because they paid a good price for them. This fact has no greater exemplification than in the purchase of babbitt metal, and is due to the great uncertainty which exists, not only among consumers, but among manufacturers, many of whom carry on their business much the same as the patent-medicine man.

Lead, Antimony and Tin: I do not wish it understood that antimony-lead is the cheapest alloy to use under all circumstances; not so, for when high pressures are to be encountered, tin is a very desirable adjunct. Tin imparts to the lead-antimony alloy rigidity and hardness without increasing brittleness, and can produce alloys of sufficient compressive strength for nearly all uses. The structure of a triple alloy of this nature is quite complicated, and not yet definitely defined.

The cost of the alloy increases with increase of tin; but for certain uses, where sufficient compressive strength cannot be gotten by antimony, because of its accompanying brittleness, it is indispensable, and will answer in nearly every case where the tin basis babbitts are used.

Tin and Antimony: These are seldom used alone as bearing alloys, but are extensively used for so-called Brittania ware, and in equal proportions for valve seats, etc.

Tin, Antimony and Copper: This combination is what is known as genuine babbitt, after its inventor, Isaac Babbitt, who presumably was the first man to conceive the idea of lining bearings with fusible metal. The formula, which for no arbitrary reason he recommended, is as follows:

Tin	89.1
Antimony	7.4
Copper	3.7

This formula is still considered the standard of excellence in the trade, and has been adopted by many of the leading railroads, the United States Government and many industrial establishments. It is used in the majority of cases where cheaper composition would do equally as well. It is the most costly of all bearing alloys because of the high content of tin.

Tin-Antimony-Lead-Copper: This quadruple combination of metals I will not venture to describe, as it would no doubt take years of study to fathom the complicity of the metallic combinations here represented. Suffice it to say that lead, although of itself a soft metal, renders this alloy, when added in but small proportions, harder, stiffer, more easily melted and superior in every way to the alloy without it, and yet consumers will raise their hands in horror when a trifling percentage of lead is found in their genuine babbitt. This is one of the instances where cheapening of the product is beneficial.

The foregoing represents the more important combinations of alloys of tin and lead basis. These are of far more importance in the arts than the white metals, the main portion or basis of which is zinc.

At various times new combinations of zinc have been proposed, but so far as my knowledge goes, they have not come into popular use for two reasons: First, because of the great tendency of zinc to adhere to iron when even slightly heated. What is technically known as galvanizing the journal is effected under these conditions. Second, because of the brittleness produced under the effects of heat, such as is produced by friction when lubrication is interfered with, and consequent danger of breakage.

Bronzes.

Bronze is the term which originally was applied to alloys of copper and tin as distinguished from alloys of copper and zinc.

Copper and Tin: This, according to our general conception of the word, is a bronze only when the copper content exceeds that of the tin. According to the proportions in which the metals exist, it has widely different properties. In general, the tin hardens when present up to proportions of 30 per cent., or perhaps a little over, and when this limit is exceeded, it takes on more and more the nature of tin until pure tin is reached. From a scientific point of view this alloy is one of the most interesting and has attracted the attention of many investigators, who have spent years of study on it, to learn its various properties and explain its constitution.

The alloys which interest us most, however, are those which are so constituted as to be adapted for bearing purposes. These would be said to contain from 3 to 15 per cent. tin, and from 85 to 97 per cent. copper. The alloy of tin containing smaller percentage of copper is often used as a babbitt metal, but this comes under the class of white metals, which I have already discussed. Bronze containing above 15 per cent. of tin has been recommended at various times for bearings owing to its hardness, but very unwisely, for such a bearing assumes mechanical perfection and perfect lubrication. It has no plasticity of its own, and as soon as the oil film is interrupted rapid abrasion and gripment take place, with hot boxes as the result. The very erroneous idea is still held by many, that to resist wear and run with the least possible friction a bearing alloy must be as hard as possible. It is true that hard bodies in contact move with less friction than soft ones; but the alloy which is the least liable to heat and cause trouble is the one which will stand the greatest amount of ill use; by this I mean an alloy which has sufficient plasticity to adapt itself to the irregularities of service without undue wear. The enthusiasts over hard bearings have even gone so far as to try glass for this purpose, and whereas this substance may give satisfaction on perfectly adjusted light spindles, for example the jewel bearings of a watch, we can readily imagine what would be the consequence if such a trial was made on locomotive or car journal bearings. It is for the foregoing reasons that I have limited the useful bearing alloys of copper and tin to those containing less than 15 per cent. tin, and began my investigation from this point.

The alloys of copper and tin were used extensively some twenty or twenty-five years ago, and were considered the standard for railroad and machinery bearings. The old alloy, known as "Cannon Bronze," containing 7 parts copper and 1 part tin, is still being specified by some few unprogressive railroad men and machinery builders.

COPPER AND TIN, AND COPPER, TIN AND LEAD SERIES.

	Copper.	Tin.	Lead.	Friction.	Temp. above Room.	Wear in Grams.
1	85.76	14.90	.....	13	50	.2800
2	90.67	9.45	.....	13	51	.1768
3	95.01	4.95	.....	16	52	.0776
4	90.82	4.62	4.82	14	53	.0542
5	85.12	4.64	10.64	18½	56	.0380
6	81.27	5.17	14.14	18½	58	.0327
7	75?	5?	20?	18½	58	.0277
8	68.71	5.24	26.67	18	58	.0204
9	64.34	4.70	31.22	18	44	.0130

Copper, Tin and Lead: This composition is now recognized the standard bearing bronze, its advantage over the bi-compound coming from the introduction of lead. The bronze containing lead is less liable to heat under the same state of lubrication, etc., and the rate of wear is much diminished. For these reasons and the additional fact that lead is cheaper than tin, it seems desirable to produce a bearing metal with as much lead and as little tin as possible. The metal known as Ex. B. composition tin 7 per cent., lead 15 per cent., copper 78 per cent., is stated by Dr. Dudley to be the best that can be devised, this being the smallest quantity of tin that will hold the lead alloyed with the copper. By adding a small per cent. of nickel, however, to the extent of one-half to 1 per cent., a larger proportion of lead may be used, and successful bronzes have been made which contained as much as 30 per cent. lead by this process. Such bronzes, containing a large amount of lead, through the addition of nickel, are known in the trade as "Plastic Bronzes" and are a regular commercial article. The table above gives the results of tests on different compositions of bronzes.

* * *

One of the interesting and valuable features of the steam turbine is that there appears to be practically no limit to the size which single units may be built. In fact the larger the wheel the better, since the peripheral speed of both large and small wheels should be about equal, and given the larger wheel, the less, of course, the number of revolutions per minute.

LOUISIANA PURCHASE EXPOSITION.

PRELIMINARY PLANS—THE ENGINEERING FEATURES.

Work has so far progressed upon the buildings and grounds of the Louisiana Purchase Exposition, and the plans have been so far developed, that it is now possible to give definite information upon many of the features of the exposition, with reasonable assurance that they will be carried out as outlined. We present a reproduction of a photograph of Machinery Hall, taken August 10, showing the state of completion, and also an engraving of the latest ground plan of the exposition. Nothing is shown on this plan save items which are either completed or in process of completion or definitely contracted for. As a matter of fact there are a great many features not shown on this plan, which, however, are practically decided on and which will completely fill the apparently unoccupied spaces of the map. For example, the entire section called "The Pike," lying to the north of the Varied Industries and Transportation Buildings, and the sections lying between the Transportation and the English section; and between the Machinery and the French sections and thence southerly to the east of Skinker Road, is devoted to concessions and constitutes the "Midway." Since July 15th practically all of this space has been allotted to concessionaires. To give a clearer and more immediate idea of the general character of the Exposition plan, special prominence is given on the map to the Intramural Railway; and the waterways, the Machinery Building and the Steam, Gas and Fuels Building, called on the ground plan the "Boiler House," are made more conspicuous by cross-sectioning.

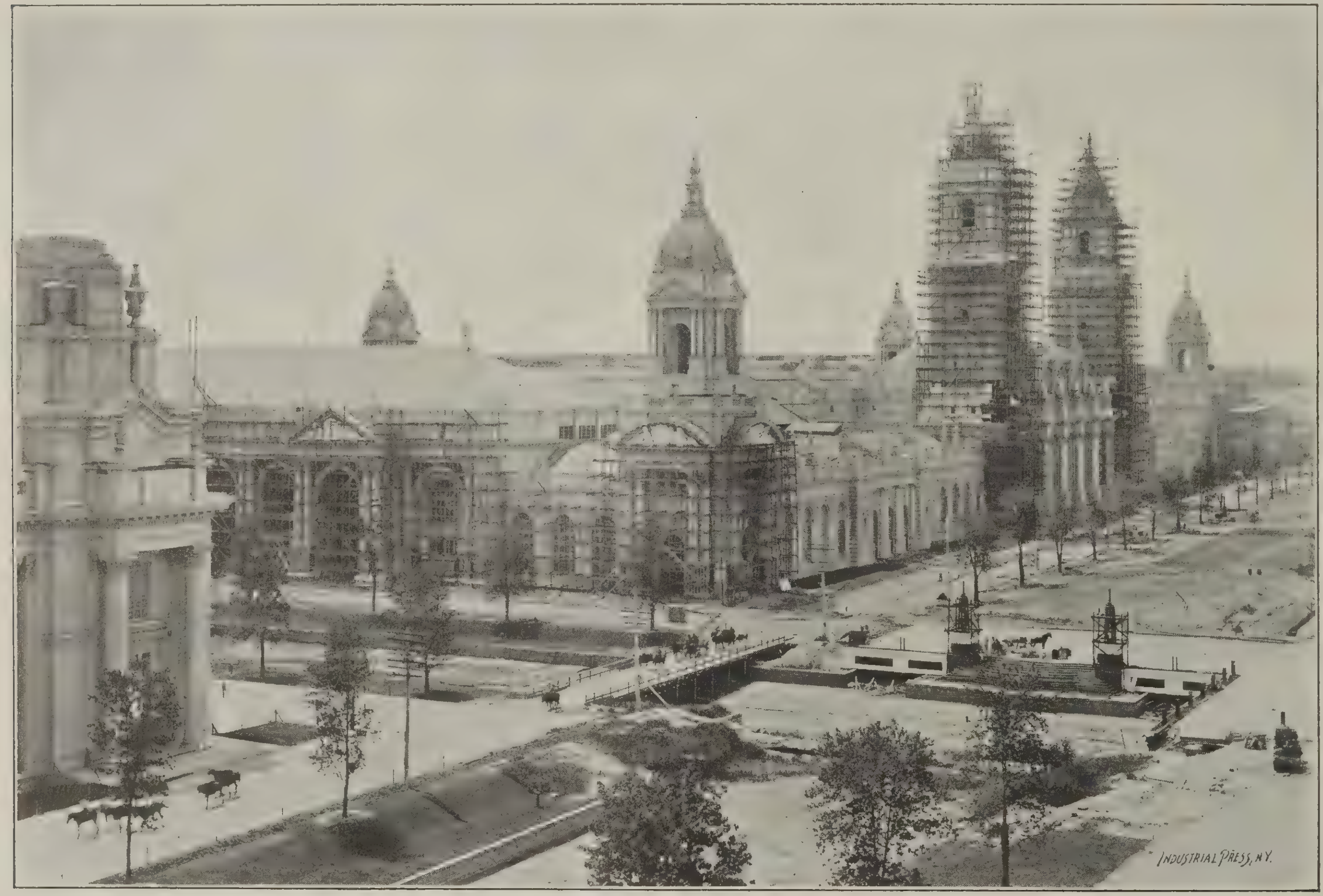


Fig. 1. Machinery Building, now nearly Completed.

With reference to the Intramural Railway, this consists of a double-track trolley road, standard gage and standard type of open cars. The motor equipment and control is furnished by the General Electric Company; the brake equipment and control is furnished as an exhibit by the National Electric Company; the power plant for the operation of the road will be located in the central portion of Machinery Hall and the prime movers in this plant are as follows:

1. A 1,500 B. H. P. Oechelhauser system gas engine (100 R. P. M.) built and exhibited by A. Borsig, Tegel-Berlin, and supplied with gas from a producer plant built and exhibited by Julius Pintsch, Berlin.

2. A 900 H. P. Corliss type steam engine (85 R. P. M.) built and exhibited by the Murray Iron Works Company, Burlington, Iowa.

3. A 750 H. P. modified Corliss steam engine (100 R. P. M.) built and exhibited by the Lane & Bodley Company, Cincinnati, Ohio.

4. A 600 H. P. four-valve steam engine (150 R. P. M.) built and exhibited by the Harrisburg Foundry and Machine Works, Harrisburg, Pa.

The Crocker-Wheeler Company, Ampere, N. J., build the generators, which in every instance are directly coupled to the prime movers and deliver current at 550 volts at the switchboard.

In addition to the foregoing there will probably be included in this Intramural Power Plant a combination which, while not economical in efficiency, will have features interesting to the engineer and attractive to the public. This combination consists of a steam pump built and exhibited by the Jeanesville Iron Works Company, Jeanesville, Pa., which is planned to deliver 1,200 gallons of water per minute at a pressure of 300 pounds, the water being conveyed through a pipe line and delivered against a tangential water wheel built and exhibited by the Abner Doble Company, San Francisco, Cal. This water wheel will be encased in plate glass. It will run at 900 R. P. M., and it is to be directly coupled to a Crocker-Wheeler generator. Incidental features will be a Lombard governor on the water wheel and a Venturi meter measuring the water delivered through the pipe line. The Intramural Power Plant will have its own independent system of boilers, stokers, force draft apparatus, piping, condensers, pumps, etc.

With particular reference to the water ways, the main one consists of a grand basin with lateral lagoons. The water is delivered into this basin from a niche in front of Festival Hall and from fountains in front of two ornate restaurant buildings which flank the Terrace of States. From these three points it flows over cascades and it is to be illuminated by electric lights placed under the lip of each step, which breaks the spill. The water is to be lifted by three centrifugal pumps built and exhibited by the Henry R. Worthington Company. Each pump is planned to deliver 30,000 gallons of water per minute against a total head of 158 feet. Three induction-type motors, each of 2,000 H. P. rating, are to operate the pumps. The magnitude of this feature will be better appreciated by the statement that the total water moved in the Paris Exposition of 1900 was about 4,500 gallons per minute and at the Buffalo Exposition of 1901 about 7,000 gallons per minute, while here in this cascade feature alone we are to move 90,000 gallons per minute. The energy required for the operation of this feature equals the total energy had from the Niagara power plant by the Pan-American Exposition and the total energy used for illuminating the latter exposition. The secondary water system consists of Arrow Head Lake. This lake is to afford an opportunity to illustrate the water dwellings and water life of the Philippines. There is a proposition on foot to afford Messrs. Farcot Freres & Company, St. Ouen-sur-Seine, France, an opportunity to install in the center of this lake a fountain which they claim will project a free jet of water to a height of about 250 feet. As the normal level of the water in Arrow Head Lake is about 40 feet higher than the water level in the grand basin, this jet would have an extreme elevation as above the surrounding country of approximately 300 feet, and when illuminated it should be visible within a radius of from ten to twenty-five miles. Messrs. Farcot Freres & Company furnished the pumps for the water display in the Paris Exposition of 1900. The particular pump which they suggest for this jet is to be driven by electric motor and it is claimed will not require more than 250 H. P. for its operation.

With particular reference to Machinery Hall and the Steam, Gas and Fuels Building, it is very gratifying to note that they will be found near the center of the grounds. The Steam, Gas and Fuels Building is a steel structure covering an area of about 100,000 square feet, and is well adapted for the installation of the class of exhibits which it is to contain. The topics to be covered by exhibits in this building are the storage, handling, preparation and conveying of fuels; the conversion of natural fuels into briquettes; the production of gas for power uses; the purification of water for boiler use; the generation of steam in boilers of both the stationary and marine types; mechanical stoking; force draft, and any subjects relating to steam generation, control and transmission. The management have done well in giving the exhibits so prominent a position, as in all former expositions the boiler house has been a boiler house pure and simple and always tucked away somewhere in the background and removed from a point where the exhibits attracted the attention of the public.

Machinery Hall is practically finished and is said to be the best exhibit building ever constructed. It has good light and air; freedom of vision and long vistas; a floor immediately on the ground level and a foundation soil naturally good. Prime movers and their accessories will occupy the westerly half of Machinery Hall. There will be found there a total of something over 40,000 H. P. of steam and gas engines doing duty and furnishing the power for the operation of the Exposition. Among the most notable units will be the following: An 8,000 H. P. and a 5,000 H. P. steam turbines; a 5,000 H. P. Allis-Chalmers Manhattan type reciprocating steam engine; a 3,500 H. P. Belgian, a 1,750 H. P. and 900 H. P. German, and an 1,800 H. P. American gas engines; a 1.500 H. P. vertical French steam engine giving 330 R. P. M. and working in parallel on arc lighting service with a German tandem compound steam engine of 1,000 H. P. and 94 R. P. M. The full range and ratings will be illustrated in each of the three great groups of prime movers—reciprocating steam engines, steam turbines, and explosion engines. In practically every instance, generators will be directly coupled to the engines. About 80 per cent. of the energy developed will be in 6,600 A. C., three-phase, 25-cycles; this for the general lighting and hydraulic work of the Exposition, but there will also be current of 2,300 volts, 50 cycles, three phase A. C., generated by foreign exhibits and used for the arc lighting, and there will be the 550-volt D. C.—as before referred to—for the

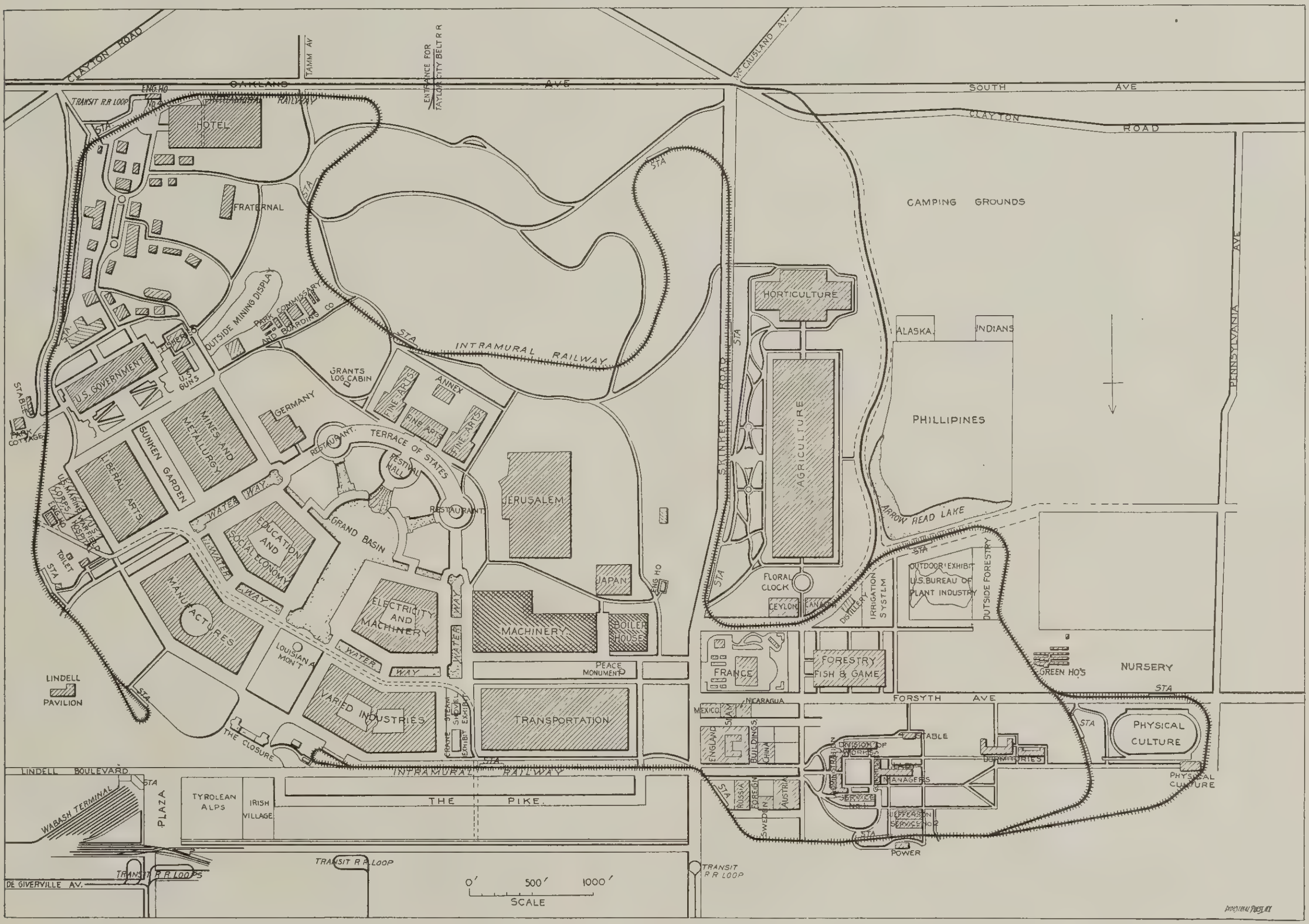


Fig. 2. Plan of Exposition Grounds as now Laid Out.

operation of the intramural road. There will also be minor installations for the generation of both A. C. and D. C. of standard voltages for the motor service of exhibitors in Machinery Hall.

To the east of the engine installation will be an air compressor plant which will furnish the air for the operation of pneumatic machinery and for the locomotives in the Transportation Building. Immediately in this vicinity the pump exhibits will be found and machine tools will occupy the northeast quarter of the building and woodworking machinery and fire engines and apparatus the southeast quarter of the building.

* * *

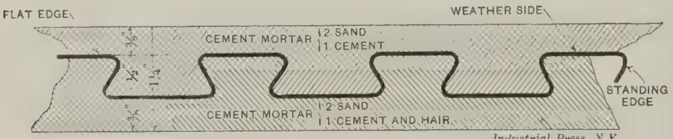
MACHINE SHOP ROOFS,*

WITH DESCRIPTION OF A SPECIAL STEEL-CONCRETE CONSTRUCTION.

One of the largest foundries and machine shops to be destroyed by fire in recent years was that of the Brown Hoisting Machinery Company, Cleveland, O., whose plant burned in December, 1900, but has since been rebuilt on a larger scale and is of more durable construction.

The walls of the main building were of brick, supporting the outer ends of steel trusses, of which the inner ends were supported by unprotected steel columns. The floors of the building were of 2-inch plank, nailed to 4 x 4 stringers, set in 18 inches of cinders. The roof was of plank covered with slate. A corrugated iron covered gasoline tank was in the end of the building and it was in this that the fire started through the carelessness of a workman. Once under way, it spread with such rapidity as to travel the length of this building, and out around a "U"-shaped building to the street in less than seven minutes. As a result the whole plant was destroyed, with the exception of the office building and a small pattern vault, which were accessible on all sides by a 16-foot driveway.

In erecting the new plant, the office building was moved across the street and out onto a vacant lot, where wings were built on each side. The area covered by the "U"-shaped building referred to, and most of the other buildings of the old plant, is now occupied by a single structure 500 x 312 feet. In addition to this a pattern shop and pattern vaults have been erected and a power house, service building, and warehouse are in process of design and construction.



Industrial Press, N.Y.

Fig. 1. Section of Ferroinclave Steel-concrete Roof.

One reason for the rapid spread of fire in the old plant was the wooden roof construction. It was determined that in the new shops this fault should be corrected and an extended investigation of various forms of roof construction was begun, Mr. Alexander Brown, vice-president of the Brown Hoisting Machinery Company, giving the matter his personal attention. In the new works it was considered necessary that cranes should be high enough above the floor to place heavy parts on the top of machines which were 40 or 50 feet high, and before designing the trusses it was necessary to decide on a fireproof roof which should be light and inexpensive. Slate laid on light steel supports would condense moisture badly; ordinary corrugated iron was objectionable for the same reason; roofing tile entailed a large number of purlins, which made the expense of the structural work very high, and also they were not at all suited to the saw-tooth roof construction. This brought the matter down to a concrete roof. The majority of those upon the market had to be made from 2 inches to 3 inches thick to obtain sufficient strength to span 5 feet. To keep the weight down, some concerns recommended the use of cinder concrete with a steel reinforcement. This could not be expected to be permanent on account of the action of the cinders in rusting away the reinforcing metal. In addition to these points, the concrete roofs were very expensive, especially when the cost of the excessive amount of structural work for supporting the roof was added to the cost of the roof itself.

These considerations finally led to the design of a steel-concrete roof which is used on all the new buildings and has now been placed on the market under the name of "Ferroinclave" roofing. A section of the roofing is shown in Fig. 1 and the half-tone illustrations indicate its appearance when completed and under construction and illustrate the method of applying it. It was determined that a cement roof 1¼ inch thick would be sufficient to prevent undue condensation and it remained but to devise a reinforcing material that would have sufficient strength to support a snow load of 30 pounds per square foot. The reinforcing sheet adopted is of corrugated sheet steel, made 10 feet long, 20 inches wide, and ½ inch thick, of No. 24 metal. The corrugations run the long way of the metal and are in the form of a dovetail. As they are wider at one end than at the other, one sheet will shingle edgeways into another sheet.

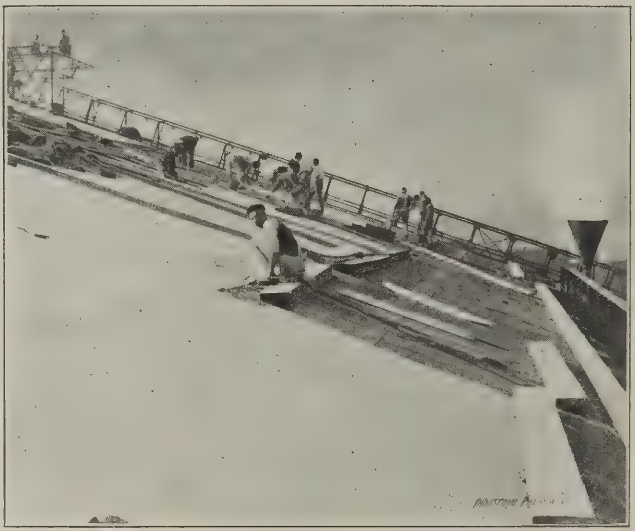


Fig. 2. Applying Cement to the Corrugated Steel Sheets.

The sheets are laid upon the tops of the purlins, spaced 4 feet 10½ inches, and clipped to them in very much the same manner as an ordinary corrugated iron roof is laid. The metal is stiff enough to support the weight of the laborers, who then spread upon the upper side a mixture of two parts of sand and one part of Portland cement. The under side of the roof is coated with a similar mixture, which contains also a small amount of lime and hair. This is put on the under side in the same way that plaster is put on to the ceiling of a room. When the cement has set for about ten days, the upper side is coated with two coats of a special non-drying paint, which renders the roof perfectly water-tight.

In the circular from which we have taken most of the facts appearing in this article, Mr. Edward Atkinson, the director of the Insurance Engineering Experiment Station, says that for years a suitable outside covering for roofs has been sought, adapted for flat roofs, or roofs of half-inch pitch, that should be as durable and safe as the composition roof of tar and gravel and, if possible, lighter in weight. Outside the practice in slow-burning construction, omitting the costly fireproof buildings with roofs of brick, concrete and steel, the roofs of miscellaneous buildings are usually the most unfit and dangerous parts of buildings in respect to the spread of fire. The great Boston fire spread by way of the roofs. The worst type of roof is the pitched roof of boards, laid on joists 18 inches to 2 feet on centers, covered with slate; worse when sheathed and ceiled inside than when not so finished within. The roof of flat section, of boards laid on joists, sheathed underneath, is bad and dangerous. For isolated buildings in the country the roof of boards, shingled outside, is somewhat unsafe and liable to be set on fire by sparks, while it transmits heat readily. On the other hand a roof of matched boards with shingles laid over half inch of lime mortar, is safe, non-conducting, and very durable.

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*For most of this article we are indebted to a recent report of the Insurance Engineering Experiment Station, Boston. While the description relates mainly to one type of roof, the facts presented comprise a valuable supplement to the articles on shop construction that have appeared in our columns.

Prof. Charles L. Norton, of the Massachusetts Institute of Technology, has submitted samples of Ferroinclave roofing to test and reports as follows:

Under the action of fire against the lower side, the roofing became gradually heated through until at the end of an hour bits of wood were charred upon being placed in contact with the top of the roof. The temperature of the fire was from 1,700 deg. F. to 1,900 deg. F. A few cracks developed on both sides of the slab in less than ten minutes, but none of them penetrated further than to the steel sheet, and no fire came through the slab during the four hours' test.

At the end of two hours the temperature of the top of the roof had risen to the igniting point of wood, but at the end of four hours it had not risen sensibly higher. Upon cooling with a stream of water the roof was found practically intact, except for a softening of the lower surface, and the development of a few fine cracks in each surface—none penetrating more than half way through. The condition of the roof was such that it was still at the close of the test a good fire stop and with a little cement plastering it would have been, in appearance and efficiency, in its original condition.

A second test was made to determine the conductivity of the roof and its liability to cause condensation. Its thermal conductivity or heat-carrying power is nearly six to eight times that of a 2-inch spruce plank, and the condensation or drip on the lower side would be much greater. It is impossible to make an accurate estimate of the amount of this condensation. The experience of a whole winter is needed to settle the matter definitely. I see no reason to question the permanency of the roofing. There is no danger of the steel web being corroded if the cement is properly applied.

To sum up: The roofing is a fire retardant of a high order; is itself incombustible; more liable than wood to cause a drip; durable, strong and light.

In the matter of cost, comparative figures are given for a Ferroinclave roof, a foundry or machine shop roof of ordinary construction, and the cost of an ordinary roof equipped with a sprinkler system for its better fire protection. The items for the Ferroinclave roof are as follows, for a square of 100 square feet, the cost of cementing presumably being at the labor rates prevailing in Cleveland:

	Per Square.
Ferroinclave sheets	$8.50
Fastening clips	.48
Laying Ferroinclave	1.25
Cementing upper side	3.00
Cementing under side	4.00
Water-proofing coating	1.50
Sundries, freight, superintendence, etc.	1.27
Total	$21.00

The items for a roof of common construction are as follows:

	Per Square.
Plank, including nailing strip on purlins	$6.90
Laying	3.00
Painting on under side of plank (two coats)	1.75
Tar and gravel roof	4.50
Apportionment for repairs for tar and gravel roof, on the assumption that the life of this roof is ten years	.45
Total	$16.60

The plank roof coated with tar and gravel will weigh about 10 pounds per square foot. The Ferroinclave roof is about 1¼ inch thick and weighs 15 pounds to the square foot. A snow load for each of 30 pounds per square foot must be provided for, so that the purlins and trusses must be designed to support 40 pounds per square foot of roof in one case and 45 pounds in the other—substantially the same weight. To equip a plank roof with sprinklers is estimated to cost $35 a square, including underground connections, gravity tank, valves, etc., assuming the roof to cover a total area of 124 squares. The cost alone of sprinklers and pipe connections for same would be nearly $7 per square.

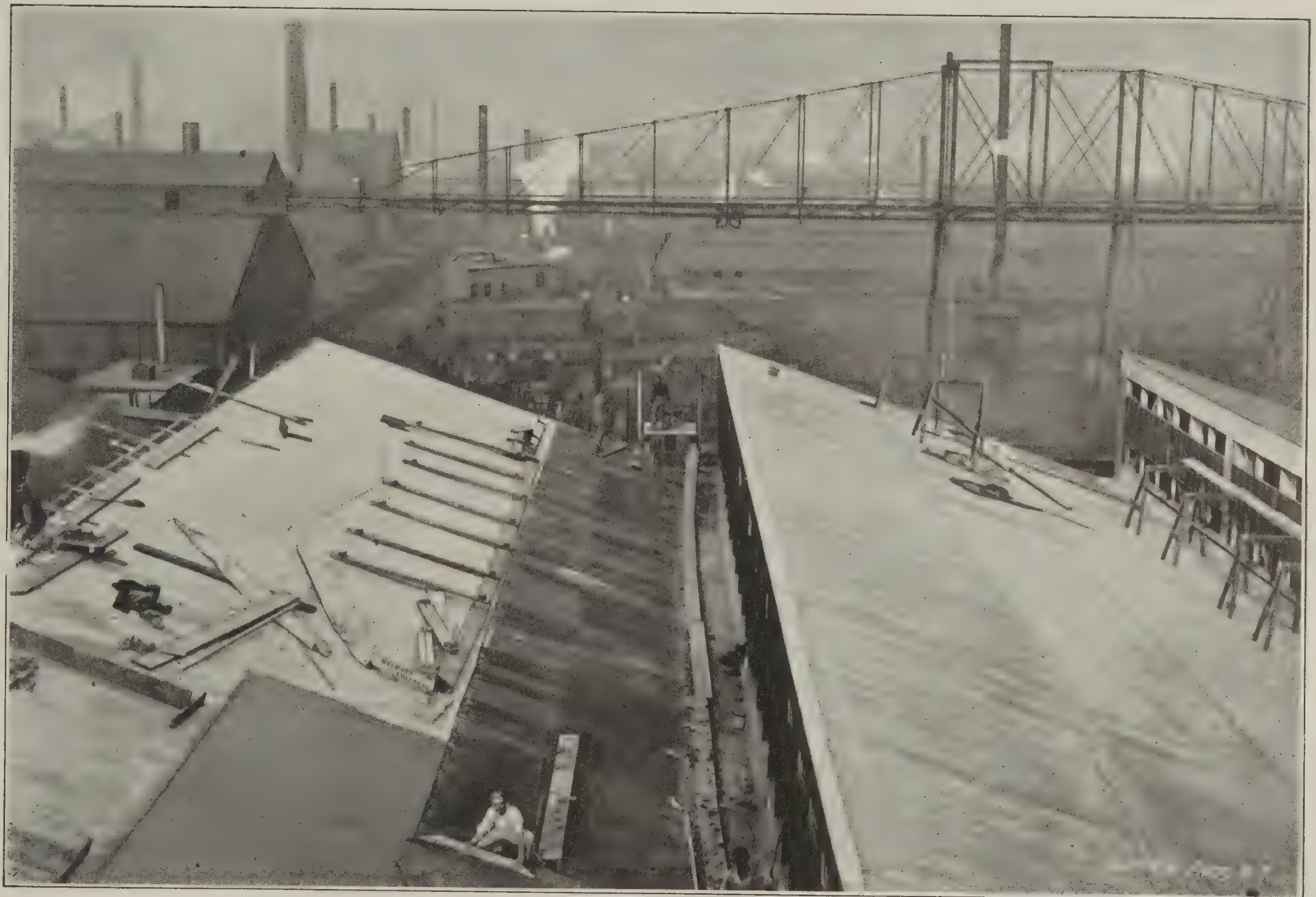


Fig. 3. Part of Roofs of New Shops of the Brown Hoisting Machinery Company, Cleveland—Steel-concrete Construction.

* * *

The addition of nickel to steel gives a two-fold advantage: First, it increases the strength and ductility of a steel of given carbon content; and second, permits the use of a higher carbon and therefore stronger steel, because it gives the high carbon steel greater endurance under shock. The characteristics of nickel steel are toughness, great tensile strength, high elastic limit, and the ability to withstand shock.

MACHINE SHOP EQUIPMENT.—2.

THE EQUIPMENT OF THE TOOL ROOM AND STORE ROOM

OSCAR E. PERRIGO.

Before proceeding with the regular text of this article the writer desires in this formal and public manner to heartily thank the many manufacturers who have very kindly sent valuable catalogues, circulars and other printed matter, and even blueprints of their products, as well as letters of approval and good wishes for the success of this series of articles. These favors show emphatically the broad-mindedness of the busy manufacturers and a commendable desire to assist in any effort to spread useful information in reference to mechanical subjects.

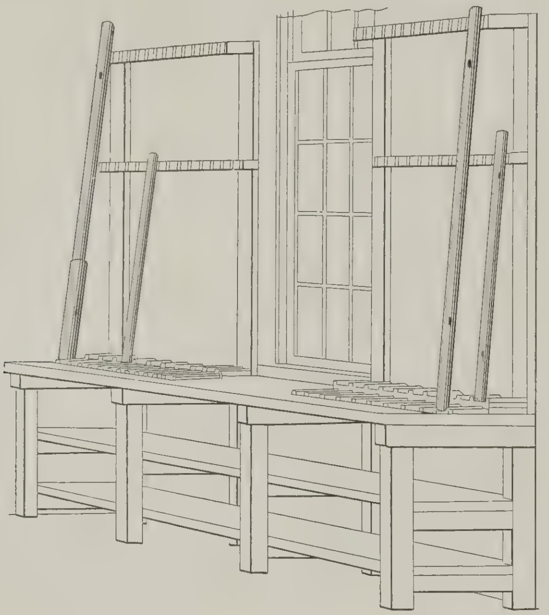

Industrial Press, N.Y.

Fig. 1

In the previous article we considered in detail the machine tool equipment necessary in the various departments of the machine shop, and the location of the machines in each group or department, all arranged for convenient supervision and for the ready handling of the stock and the finished parts.

In that article the *machines* in which the work was to be done were considered. In this article it is proposed to consider the *tools* for use in these machines, including a department for making them and proper arrangements for their care, such as providing a place for their safe keeping and regular issue to the shop. It is also proposed to consider, in connection with the store room for tools, the arrangement of the store rooms for the smaller kinds of rough stock, and such purchased parts as are received complete from outside dealers or manufacturers. This plan leads us into the office portion of the building, and consequently a brief explanation of this part of the establishment does not seem out of place, inasmuch as it is, in a purely manufacturing plant, so intimately connected with all the machine shop operations, rather than partaking of the commercial side of the marketing of the product.

The large cut, Fig. 3, accompanying this article, is a plan of the front portion of the machine shop building, showing the relative location of the offices, tool making department, store rooms, etc., and the essential parts of their internal arrangements.

The main entrance to the office part of the buildings is through wide double doors from a large porch and opening into a public space in the portion devoted to office arrangements. The divisions of this portion of the building are clearly shown in the drawings. Upon the outer side are located the superintendent's public and private offices, between which is the stairway leading to the drawing room above, and the necessary toilet conveniences. The public space is separated from the large central space of the general office by a railing, doors opening from both these into the superintendent's public office. The bookkeepers' desks are so arranged that a cashier's window opens into the public space. The timekeeper's desk is surrounded by wire netting, secluding his work from the general work of the office. A door leads into the gateway space, across the large platform scales and into the tool room portion of the building opposite. At one side of this door and as far away from the general work as may be is the telephone booth. A wide hall leads from the central space to the machine shop proper, and divides the private office from the purchased parts store room. This latter is so placed because the purchase, receipt and issue of such stock is more intimately connected with the office work than that of the rooms in the opposite side of the building.

The tool making department is purposely placed away from the general machine shop, as a too intimate connection with it does not seem desirable in practice, while it should be convenient to the drawing room and the pattern shop, which may be reached by the stairs next to the rough stock room, as shown. It occupies the entire front of this square, front structure and is provided with a variety of machines rendered necessary for the making of modern tools and fixtures for properly machining small or medium sized parts. The character of each of these machines is indicated on the drawing. It is also provided with the grinding machines for grinding such tools as lathe tools, planer tools, twist drills, etc. It will be noticed that in providing the machine tools for making jigs and fixtures particular attention is paid to grinding facilities since these are in many cases the best adapted to such accurate work, both as to producing good work and to doing it economically. Large pieces of heavy fixtures may, of course, have to be planed in the planing department, but these cases will seldom occur. The tempering of tools will best be done in the forge shop, the tools being sent there in quantities when possible, rather than to attempt such work in the tool making room with hand forges.

A foreman's office is provided so that he may have a proper place for keeping the records of the work of the department as well as a private room for convenience in making such sketches, plain drawings or details as he may find necessary in carrying out the plans for tool making; these are not always worked out in sufficient detail by the drawing room force, or such as he may wish to devise himself for special work and develop as the necessities for them may arise.

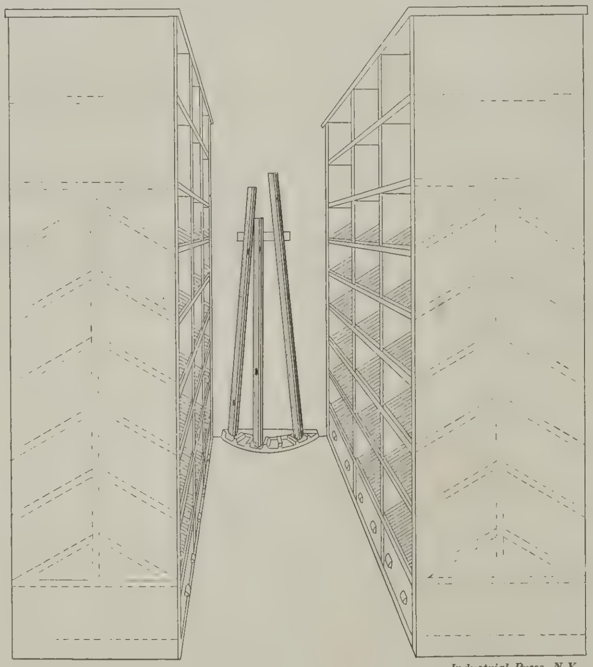

Industrial Press, N.Y.

Fig. 2.

To avoid confusion in the tool making department, a tool store room is provided, where the usual supply of lathe and planer tools, twist drills, taps, reamers, arbors, etc., is kept and issued to the tool-distributing points such as the general room near the engine room and the foremen's offices. In this room are also kept, when they are not in use, the jigs and fixtures necessary for machining small parts, as they can be better cared for here than in the machine shop. The en-

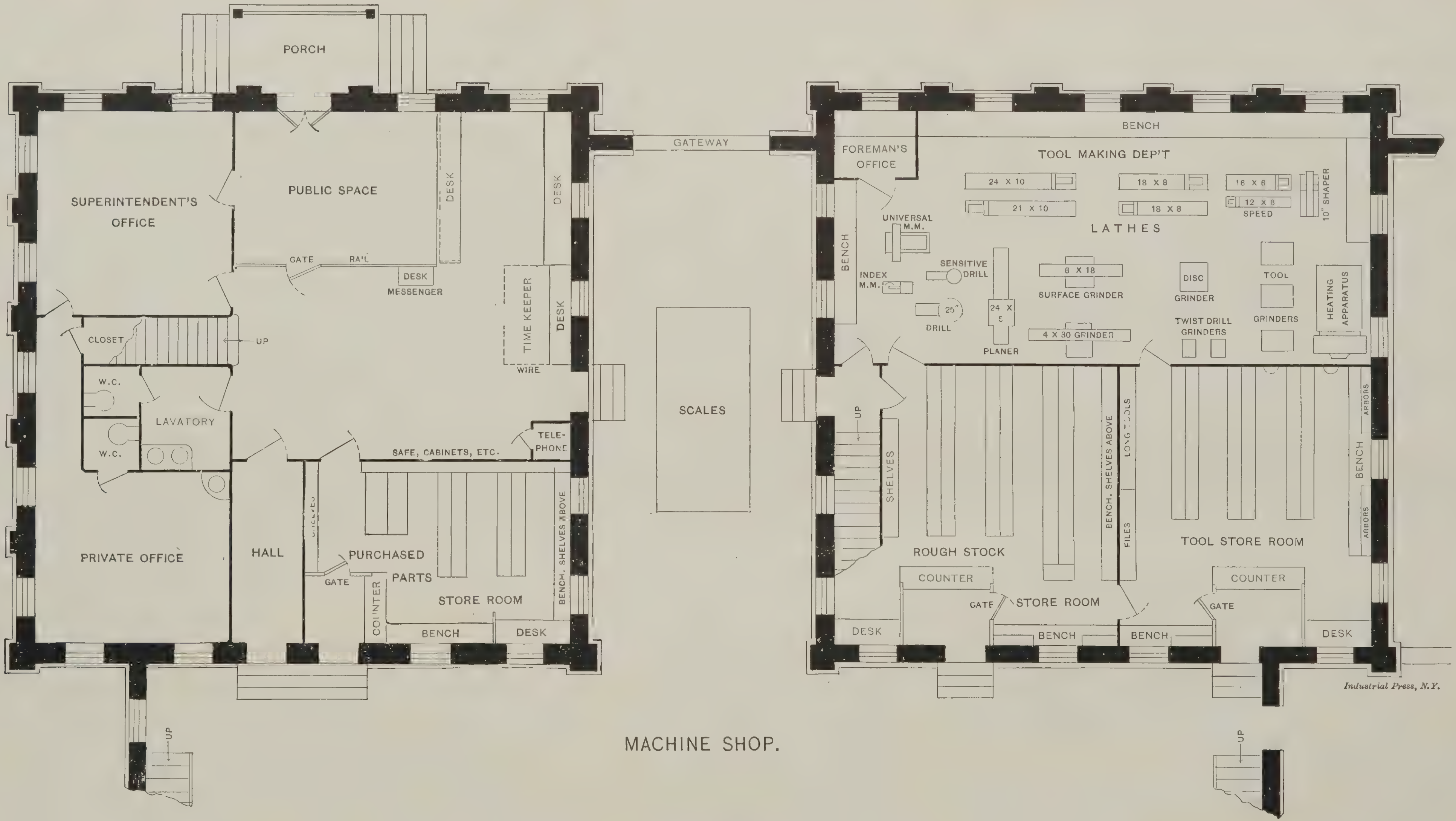


Fig. 3. Plan View of Shop Offices, Tool Room and Store Room, all of which adjoin the Machine Shop.

trance to this room for the workmen is so arranged that he enters a space in front of a counter and has no access to the main space of the room. This will prevent confusion and enable the tool keeper to do his work quickly and properly. To save unnecessary distance in reaching all tools and fixtures the alcoves of shelves are so placed that the alleys all terminate near the issuing counter. At the right is a convenient bench arranged with arbor racks as shown in Fig. 1. These racks will accommodate arbors from four to seven feet in length. The same form of racks may be arranged for any length too long for conveniently placing on the shelves. Beneath this bench are strong shelves upon which may be placed heavy jigs and fixtures. Fig. 2 shows cases of inclined shelves arranged with strips for holding such tools as drills, reamers, short arbors and similar tools, and at the far end another form of arbor rack. This may, if preferred, be arranged similar to the arbor rack shown in Fig. 1. The series of inclined shelves is continued as high as is within convenient reach, and above this point horizontal shelves are provided which will be found convenient for holding jigs, fixtures and similar articles that are seldom used, and not too heavy to be stored at that height. At the base of these cases a series of large drawers is located. They will be found very useful in storing small tools not needed on the shelves, and a variety of such articles as are best kept in such a receptacle until wanted for adding to the regular issuing assortment on the inclined shelves. In Fig. 4 is

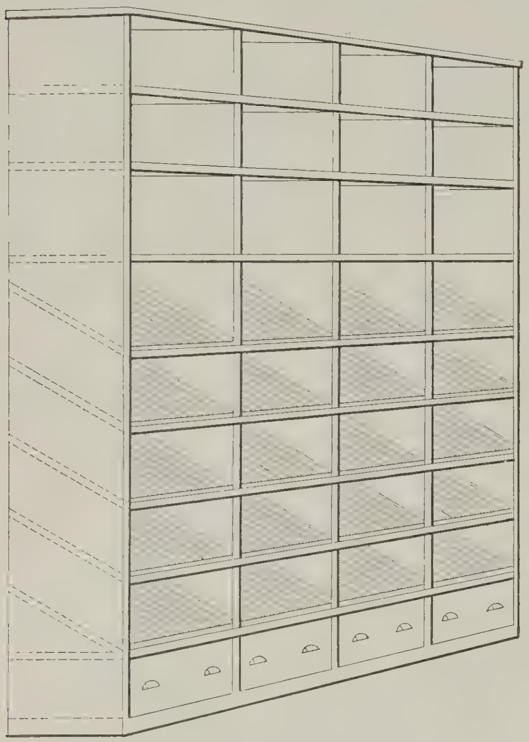


Fig. 4.

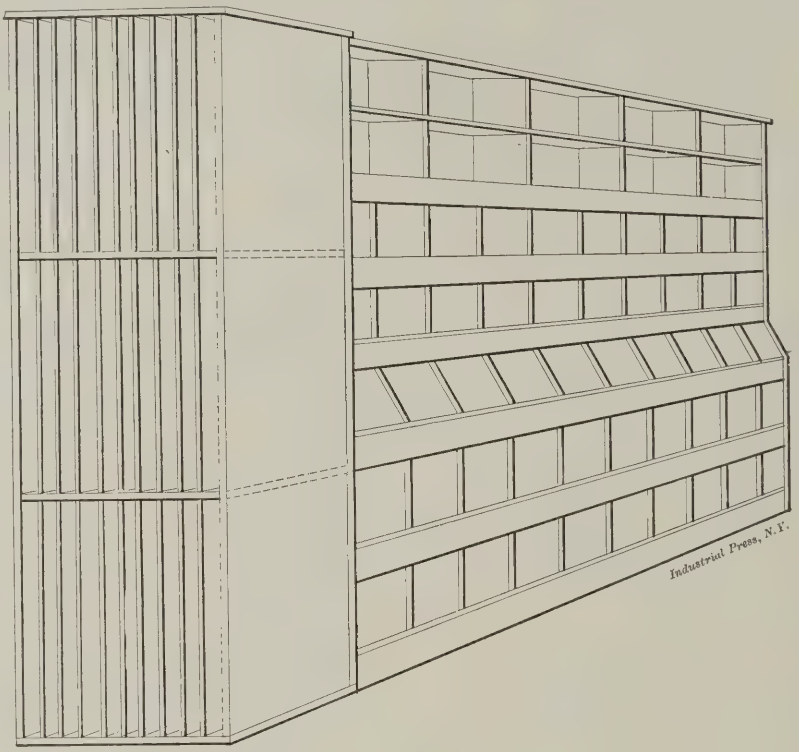
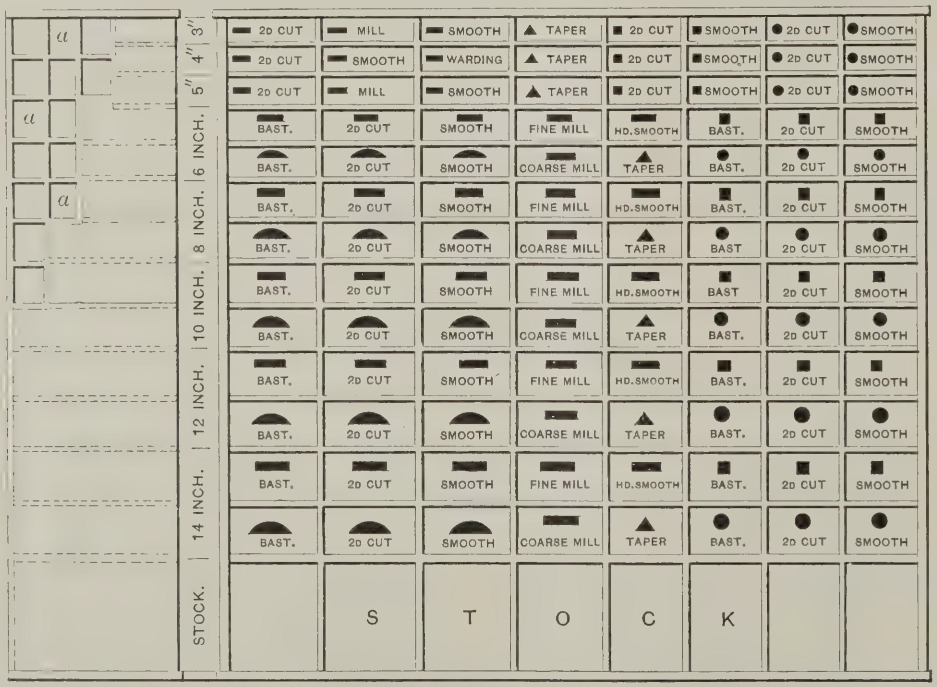


Fig. 5.

shown a form of case of inclined shelves for longer tools than can be accommodated in the cases shown in Fig. 2. Otherwise the arrangement is the same. The ends of these cases may be conveniently used for the posting of blueprint lists of regular or standard sizes of tools in stock, from which it will be easy to ascertain if a certain tool wanted is kept on the shelves. They may be used as tool check boards, being convenient to the desk and counter. Fig. 6 shows a file case in which a regular system of arrangement of the files of different lengths, cuts and shapes are provided for, so as to make the memorizing of their location easy and convenient. It will be noticed that the smaller files, as the 3-inch, 4-inch and 5-inch files, have each one shelf provided for them, while all of the larger sizes have two shelves to each length, as more different shapes and cuts of these are required. Also, that the coarsest cut is placed at the left and the triangular, square and round shapes follow them toward the right, and that the files of each length are arranged in the same regular order. This arrangement will save much time in issuing files, as well as in distributing stock when it is received. The labels showing the shape, cut and length are placed on the edge of the horizontal dividing shelves, the *shape* being shown as in the drawing. At the base, and below convenient reach in issuing, are compartments for stock. The sizes and shapes of files shown are such as are usually needed in ordinary machine shop work. If a special class of work is done these sizes and shapes would, of course, have to be modified or added to, but the same general plan might be adhered to. As the files at the top of the case are much shorter than those lower down, a waste space will be left in the rear of them. This may be utilized by forming compartments as shown at *aa*, in which drill rods or other similar articles may be placed if such are kept in this room.



Industrial Press, N.Y.

Fig. 6.

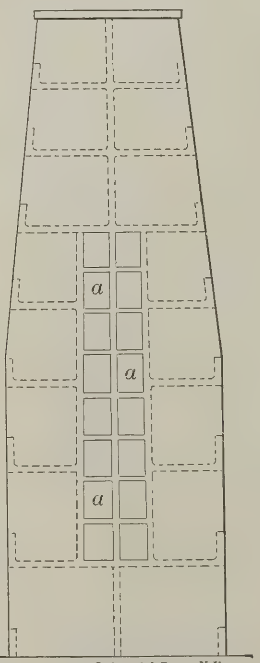


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Fig. 7.

From the window opening into the machine shop a system of tool carriers, similar to the cash carriers or the package carriers of a department store, may be run to the tool distributing room near the engine room, to each of the foremen's offices, keeping out of the way of the traveling crane, and to the galleries. These will be very useful in sending in dull tools to the tool department to be ground and in quickly returning the same. Also, in keeping these distributing points supplied with standard tools in proper condition for use. Such a system will soon save its initial cost in the time that would otherwise be spent in carrying these tools, not to consider the many delays in the work, which is usually far more important. Several matters more or less closely related to this subject will be discussed in detail in articles on the management of the work of the establishment.

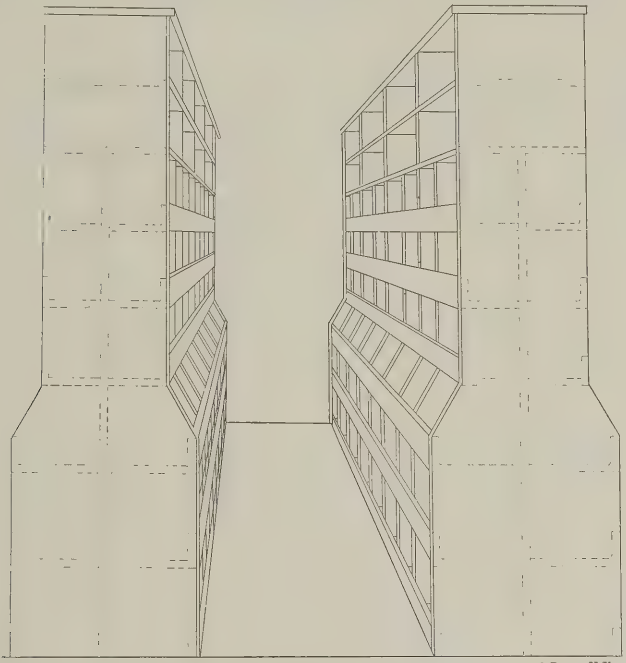
Industrial Press, N.Y.

Fig. 8.

In the rough stock store room the cases are also arranged in alcoves, and are of the form shown in Fig. 8. These are made wider at the base to accommodate larger articles which are more conveniently handled at this height than higher. The construction is plainly shown in the drawing. At the upper portion plain shelves are provided to hold articles seldom used or of such irregular form as are not convenient to store in bins as arranged below. These may be constructed with a retaining strip at each side, thus forming bins all the way across the case, if the form of the articles stored renders it necessary. In Fig. 7 is shown a modified form of these cases, in which the center portion has formed in it compartments *aa*, in which may be stored round and square cold drawn steel, brass tubing and similar articles, in a safe and convenient manner and without occupying any additional floor space. Fig. 5 shows a case, the front end of which is arranged to hold such articles as sheet brass, copper or vulcanized fiber, in a similar manner to that provided for storing large window glass. This form of construction will be found better than to lay the sheets in a horizontal position, as they can be more conveniently reached, and by providing entirely separate compartments for each thickness, small pieces can be more easily cared for and readily found when wanted.

Wire in coils may be hung upon the walls. It should be so assorted and arranged that all of one material shall be together and that the smallest size is at the top, or at the left of the group.

Various modifications of these plans may be necessary in adapting the arrangements to different conditions and classes of materials to be handled, but in a general way the construction shown will be the most useful, both as to the proper storing and care of the stock, materials and tools, and as to their convenient and consequently speedy delivery when called for.

Cotton waste, or whatever equivalent is used, may be kept in a bin built under the bench, or in a similar one built under the stairs.

A small counter scale weighing up to 80 pounds and provided with a pan for weighing small articles should be provided for the counter.

The purchased parts store room is located in the office portion of the building and is arranged in a similar manner to those just described. All articles purchased outside of the shops and in a complete form to enter into the work, are here received, stored and issued. This will include all kinds of screws, bolts, hardware, belting, belt fastenings, etc. It might include files but they are here classed as tools and put in the tool store room. Oil cans, hand lamps, file cards, emery cloth, grain emery, etc., may also be kept in the tool store room, as being more nearly allied to tools than to either rough stock or purchased parts. For the same reason it might be well to place belting and belt fastenings in this room. Returning to what may strictly be considered purchased parts, the following arrangement of them will be found to be convenient and practical, both for proper storing and for issue. Machine screws should be kept in the original gross packages, on shelves not necessarily over 6 inches in width, and for the smaller sizes 5 inches apart; for the larger sizes about 9 inches apart. For eighty sorts, say from ¼ inch, 6-32 to 2 inch 24-16, and in both round and flat heads, there will be about twenty linear feet of shelving required, exclusive of vertical supports. Setscrews are also kept in the original packages on similar shelves. Thirty-four sorts, from ¼ inch x ⅜ inch to ¾ inch x 2½ inches of both oval and cupped points, will require about twenty linear feet of shelving, exclusive of vertical supports, the shelves to be placed the same distance apart as for machine screws. While the setscrews average larger than the machine screws there are only fifty in a package, against one hundred and forty-four machine screws. Setscrews with V-points, if they are of small sizes, may be kept in the original packages, but if of larger sizes, as for shafting hangers, they are best stored loose in bins. Gib screws, being of the smaller sizes, should be kept in packages or boxes. Round head and hexagon head cap screws of small sizes, say, ¼ x 1 inch to 7-16 x 1¾ inch should be kept in packages on shelves, and will occupy about the same space as setscrews. The larger sizes should be kept in bins holding about five hundred. In arranging shelf space for machine, cap and setscrews it is assumed that there will be at least three packages of each size on hand, which will be sufficient for all ordinary purposes. Special screws are usually made in large lots and are more conveniently kept in bins.

Belting may be placed under the bench at the end of the room. The rolls should be set on edge, between vertical supporting boards, and kept in place by a strip three inches high, placed on the floor in front of the rolls. In issuing belting the roll remains in place and the portion taken off is stretched along the floor and measured to the length required.

Miscellaneous hardware should be kept on shelves, and as it is seldom called for, the higher shelves will be the proper place.

Should the amount of purchased parts be larger in proportion than is here arranged for, the door leading into the general office may be omitted, thus gaining room for one more case and making one more alcove, and a door be cut through into the hall from the space inside the rail. This would add about fifteen to twenty per cent. to the storage capacity of the room.

The desks provided in these rooms should be a fixed top about 44 inches from the floor. Twenty-four inches wide will be ample. The top should be inclined to the front about 1 inch to the foot. Drawers provided with locks are fitted under this top, and below the drawers should be three shelves 12 inches wide, the first 8 inches from the floor and the others 8 inches apart. These will be convenient for storing books, blanks, etc. The space under the counters should also contain similar shelves, but these should not contain articles of regular issue to the shop.

The stock used for building bins and cases should be generally ⅞-inch pine. The divisions in the file case and in the sheet metal case need be only ½ inch thick. It is well to paint all these fittings quite a light lead color, as it is a good wearing color, and should not be so dark as to interfere with ample light. The partitions may be of the same tint up to a line 5 feet above the floor, and above that, including the ceilings, white. The same colors will be proper for the tool making department.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.
PHILADELPHIA—Machinery Floor, The Bourse.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1903.

NET CIRCULATION FOR SEPT., 1903,—25,183 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 or more reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 or more reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

GOVERNMENT EXPERIMENTS.

The propeller planer illustrated in this number is one of a series of very ingenious machines that have been devised by the Navy Department for use in connection with the experimental model tank at the Washington Navy Yard. There is no more important subject for investigation than that of the screw propeller, which this machine makes it possible to investigate. This is particularly true since the advent of the steam turbine in marine work, requiring propellers of unusual design, for high rotative speeds, and concerning which there is but little information available. Thirty-five years ago Engineer-in-Chief B. F. Isherwood carried on an extended series of experiments upon the subject of screw propellers, and his results are standard authority to-day. But since that time government endeavors in this direction have been of a sporadic character and the efforts of individuals have not resulted in a great increase in knowledge upon this subject. What we have gained in the intervening time has come mostly from abroad. In the matter of careful investigation the Germans have led us, and the fruits of these efforts are seen in the tremendous advances in German marine construction. In commenting on this fact Admiral Melville recently made a very frank statement, from which the following is taken:

In all probability England, France and America have each spent more money than Germany in experimental work, but German expenditure, in great part, has taken place before the article is manufactured or the ship laid down, while in the case of some rival powers, at least, the tests and experiments have been conducted instead to discover means of overcoming avoidable defects. The proverbs that "an ounce of prevention is worth a pound of cure," and that a "stitch in time saves nine" are as applicable to-day as they were in the last century. It is for this reason that the preparatory experiments of Germany have been productive of greater results than those of rival powers working in the direction of seeking remedies for existing evils. The rise of Germany as a naval power during the past thirty years has surprised the world. I believe her battleships for their tonnage are the best afloat, because they possess the triple-screw installation of machinery, thus giving the motive power of her larger warships decided economical and tactical advantages. Strangest of all, this excellence in construction is not the result of a progressive series of failures, either in design, construction, or of operation. The success of Germany can be accounted for only by recognizing the fact that study, reflection, and research must have been expended in the preparation of plans, in the building up and the organization of shipyards, and in laying out and carrying on the work of construction. It was the high appreciation of the value of original investigation, coupled with experimental work, that has caused Germany to advance successfully and progressively.

* * *

ARE THE CLAIMS FOR EDUCATION MADE GOOD?

A wise man of the West has written a pamphlet which has attracted not a little attention, to show that an academic education, such as given by our best American colleges, is not beneficial to a young man who is to have a business career. In the latter part of the pamphlet the attempt is also made to show that a technical education is also of considerably less value to its recipient than it is commonly supposed to be.

It does not make so much difference where an education is obtained—whether at home, in day school or at night school. Many have obtained liberal educations who have spent very little time behind the walls of a schoolhouse. The main advantage of the school and college, over the home or other method of study, is that the work can be completed more quickly and under proper guidance, with many facilities in the way of apparatus, models, exhibits, etc., that are nowhere available except within the school walls. Hence, an arraignment of college education is really an arraignment of education itsself, wherever obtained, and it is very pertinent to ask, Does it pay?

To the open minded no argument is needed for an affirmative answer, for it is by knowledge, and knowledge only, that advances in the world have come; but if statistics are desired, Prof. Thurston, of Cornell University, has been gathering a little information with regard to the fruits of technical education, which, all things considered, we believe, indicates that education does pay, not only in the satisfaction and pleasure that it gives, through broadened views and better grasp of affairs, but in actual dollars and cents. Prof. Thurston has reports from 1,000 graduates of technical courses, and it is fitting to ask, whether similar returns from 1,000 men who have not had technical training, but who started out at the same time that these various students did, and who were in the same condition and circumstances, would show as good results. This would give a fair test of the question of education and its value, and each reader can form his own conclusion in the matter. Prof. Thurston says:

"A list of one thousand has been prepared for me, tabulated. The average period since "graduation" is about seven years. Of these, so far as reported, one-third are holding positions of independent responsibility; one-eighth are managers and superintendents of work; ten per cent. are teaching in the professional schools and twice or thrice as many are wanted. Ten per cent are designing engineers, planning the machinery of the work shops, the manufacturing establishments, the railroads and the fleets of the country. Several are editors, one-fourth are manufacturers; many are presidents and vice-presidents of corporations, others are treasurers and the balance are distributed throughout the whole system of industries of the country. One-half of these men are not above the average age of 27 or 28 years; and 95 per cent. are not over 35 or 37. Practically all retain their connection with their profession. They commonly realize and fully appreciate their advantages, educationally.

"Of the calls which I have received for men in all grades from the 'captains of industry,' 45 per cent. are for positions worth $750 to $1,000; 15 per cent. at $1,200; 20 per cent. at $1,500; 15 per cent. at $2,000; 5 per cent. at $2,500, and in many cases from two to ten men are sought. The needs are greatest in the highest positions and where men capable of carrying large responsibility and having exceptional executive capacity find their place.

"One of the best gages of the value of these men when well suited to their profession is found in the fact that when these alumni of the engineering colleges are asked if they desire to change their present positions they almost invariably reply that they are well satisfied. Asked at what salary a change would be considered 10 per cent. of these giving definite figures propose $1,000; 30 per cent. $1,500; 30 per cent. $2,000; ten per cent. $2,500 and 5 per cent. in each grade $4,000, $5,000 and $6,000. The ablest men in highest positions usually declined to consider a change of employers or of employment."

THE ST. LOUIS EXPOSITION,

WITH REPRESENTATIVE OPINIONS FROM THOSE WHO WILL AND WILL NOT EXHIBIT.

In another part of the paper is an account of the engineering and mechanical features of the Louisiana Purchase Exposition to be held at St. Louis next year, in so far as plans have been developed and work accomplished. As yet it has not been possible to secure a list of exhibitors or of space allotments in the machinery building, for at this writing assignments have not definitely been made, except in the power department. Enough is known, however, to indicate that there will be a great show of machinery, probably surpassing in quantity that at any previous exposition, either here or abroad; but whether the machinery exhibits will equal in novelty or general interest those that have been seen elsewhere, as for example at Paris or Dusseldorf, we are not prepared to predict, although the management is very sanguine in this regard. From what we can learn we think it doubtful if it will be as representative of American machinery as could be wished; but for the mechanic and engineer not familiar with European practice, it will probably present more interesting features than any American exposition since the Centennial of 1776, because of the large assignment of space already made to foreign exhibitors, who will show machinery more or less new to Americans.

Machinery Hall is a very large building, and at the outset it was supposed that it would be ample for all requirements; but as the case now stands it is stated by a representative of the department of machinery at St. Louis that it would have been possible to have filled a much larger building and that there are now more applications for space than can be allotted.

In spite of this fact, it has been evident to us that there was a very noticeable apathy among American machinery manufacturers, especially in the machine tool trade, with respect to the St. Louis exposition. Lately more interest has apparently been aroused, largely, we judge, because of the considerble number of exhibits which have been secured from abroad through the enterprise of the management. The most important of these are of steam and gas engines, with boilers and gas producers, to the extent of 40,000 horse power, in itself a most important power installation, and one of general interest to people in this country.

Some manufacturers who have had experience at expositions, but without direct returns in the way of business, have felt that it was "crowding the mourners" to ask them to spend the time and money necessary for a display at St. Louis so soon after the expositions at Paris and Buffalo, and have frankly so stated in letters to us. On the other hand, many have secured good results from exhibits and are even enthusiastic over the opportunities this show will present for the extension of their business interests. These and other views have come to us in one way or another; and to arrive at some conclusion in regard to the sentiment among the trade, particularly the machine tool trade, we addressed a circular letter to a list of the American machinery exhibitors at Paris and Buffalo. In this the conditions as we found them were stated and we asked for opinions as to direct or indirect results from previous exhibits and also if the firm addressed was to exhibit at St. Louis. We believed that a general expression of views on this subject would be of benefit to many individual manufacturers. It has been well demonstrated that to secure the best returns a display of machinery should be a "live" exhibit, with machines turning over, and that the firm must be represented by competent salesmen and capable attendants, in order to secure results commensurate with the cost of the installation. The vital question in regard to all of this is, Does it pay? And only those who have "been there" are competent to give the answer.

Eighty-three replies were received to our letter, from firms who exhibited at Paris or Buffalo, or both, and their replies may be classified as follows:

83 exhibited at Paris or Buffalo.

43 of these have decided to exhibit at St. Louis.

28 have decided not to exhibit at St. Louis.

12 are still uncertain.

22 of those who will exhibit believe that past exhibits have been profitable.

21 of those who will exhibit are not sure about results, but are going to St. Louis, either because their competitors will be there or because on the whole an exhibit is believed to be a good advertising proposition.

We have not attempted to publish extracts from all of those heard from, but in what follows are representative expressions of opinion giving as fair a resumé of the sentiment of the trade as we are able to prepare. In the first group of "Those who will exhibit" it will be noted that some state the direct returns from past expositions have been satisfactory, while others are not so sure of this, but believe in a general way that returns have come indirectly and that it is a paying proposition. A few will exhibit from "patriotic motives" and we suspect a good many because competitors are to be there. In classifying this group, we find, as stated above, that 22 out of the 43 were definitely assured of direct returns from their exhibits at Paris or Buffalo.

Those who will Exhibit, because they believe Exhibits Pay.

We will exhibit at St. Louis with a "live" exhibit, as our experience at Buffalo was a very satisfactory one in both direct and indirect returns.

As a general proposition, we believe Fairs pay. We were exhibitors at Paris and Buffalo; Paris did not pay us; we think Buffalo did.

We did not have an exhibition at Paris, but did have one at the Pan-American exposition, to which we have traced some very good results. On the whole we feel satisfied with our exhibition and the results thereof.

The Buffalo exposition proved a very profitable advertising medium for our machines, and we believe we were fully justified in making the expenditure. It is our intention to exhibit at St. Louis and we shall have a "live" exhibit so far as possible.

Our exhibits in the past have brought us sufficient direct business to warrant the expense we have been to. We do not believe that a small exhibit pays, and unless we can have sufficient space we prefer to stay out.

Are pleased to say that we obtained direct and indirect results from the exhibit at Buffalo, such as we feel justified the expense incurred. It is our opinion based on our experience, that an attractive exhibit, properly looked after, and the missionary work done, and foundation laid for getting increased and new business, properly followed up thereafter, are sure to bring satisfactory results.

As regards our Chicago and Paris exhibits, we recall having received direct returns from the former, but the results from the latter were more a matter of publicity and advertisement among a new class of trade, resulting in trial orders, which we have since been following up with good prospects. We intend to exhibit at St. Louis, believing that it will pay us to do so.

We had exhibits at Paris and Buffalo, and while it is very difficult, if not impossible, to trace the direct results of such exhibits, yet on the whole we were satisfied with the results of both of these exhibits, and we looked upon the same as perhaps being a better advertising proposition than the trade papers.

At Paris our exhibit was in charge of our foreign representatives and we believe that results proved satisfactory to them. We were unable to trace many sales resulting from our Buffalo exhibit, although we believe that the general advertising received was of considerable value. We certainly had many callers and interested many people. Under proper management we are inclined to believe that an exhibit at St. Louis would repay us for its cost.

In our opinion we received sufficient returns, both direct and indirect, from our exhibits at Paris and Buffalo to warrant the expense. An exhibition of a high character places the manufacturer before many people with whom it would otherwise be impossible to get into close contact. For these reasons and prompted by a feeling of patriotic duty, we intend to make an exhibit at St. Louis.

In our line the direct results are very small indeed but we feel that an exhibit properly attended is a good investment. If it is possible for us to secure the space which we desire at St. Louis and some one can be spared from this office to properly represent the company, we shall certainly be there with a handsome exhibit.

Our exhibit at Paris was handled through a local agent and brought us very little, if any, direct returns. Our exhibit at Buffalo, however, was under our personal supervision and we believe gave us quite a little prestige on certain machines. We undoubtedly received orders, both directly and indirectly, as a result of our exhibit, but like all other orders given on account of an advertisement we could trace only such as directly referred to our exhibit. The only thing we might add to your two questions, by way of suggestion, is that in the event of awarding medals, a different method be employed than was in vogue at Buffalo, where, apparently, any exhibitor could procure a medal. Where but one Gold Medal is awarded for each class of articles, an exhibitor would feel a natural pride in receiving such a medal.

We are strong believers in the advantages of exhibiting at such expositions as will be given in St. Louis, and we have exhibited at fourteen of the different expositions since 1874. We always prefer a live exhibit—that is, one where the machinery is running, and, if possible, producing its regular products. We think, with the exception of the New Orleans Exposition, every one of the expositions has brought us good returns and helped us to build up trade.

It is practically impossible to trace, more than in a general way, the results of making these exhibits. There is no question in our mind but that indirect returns result and warrant the expense incurred. Persons who examine exhibits of machine tools do not come prepared to place orders at the time, but an impression is made upon the party which may result in an order later on. It is one of the ways of keeping your product before the people, giving them an opportunity of examining the machine itself.

We consider that our exhibit at Buffalo brought us sufficient direct and indirect returns to warrant the expense incurred. We had power and an operating exhibit, and the expense was a heavy one. We, however, had plenty of competent, hustling, wide-awake representatives at the exhibit, and this we believe in great part made the returns. They were able and ready to take care of people who stopped and appeared interested. We kept very full records of every one whom we talked to, and we made it a point to talk to every one who stopped. These were afterward followed up.

The Chicago World's Fair was international enough in scope to pay exhibitors and we think the Paris Exposition was also satisfactory; but the one at Buffalo was more of a domestic affair and many who were there decided not to exhibit in future. We believe it is better to have an exhibit where you can show your goods to foreign buyers than to try to sell them from a catalog or samples and think the St. Louis Exposition will be much better in this respect than was the Pan-American.

We did not exhibit at Buffalo, because we could not get enough space to make a good representation of our line. We exhibited at Paris and felt well repaid, as we disposed of our whole outfit and had a good deal of trade resulting from our exhibit there. We were also large exhibitors at Chicago, and sold nearly our entire exhibit. We kept a record book with names of visitors to our space and made a number of valuable customers in foreign countries, and also sold a large bill of tools in this country. We can trace directly a great deal of benefit in the way of trade through acquaintances made at the expositions. We intend to exhibit at St. Louis and feel that it will pay manufacturers to do so if they make goods adapted to the general wants in their line throughout the world. If products are adapted to a certain locality, only, of course exhibitions cannot be of so great benefit; but we feel that there is no greater opportunity to present goods to possible buyers than at such representative expositions as the one at St. Louis promises to be. The earnestness, intelligence and straightforwardness of the heads of departments connected with the St. Louis Exposition will have much to do with encouraging manufacturers to make special efforts to exhibit there. I might add that it is shortsightedness in many exhibitors to go to a large expense to fit up fine exhibits and then place them in charge of incompetent men. They don't select as good talent to represent them as they do to prepare their exhibits, and when a possible customer comes along, seeking information regarding the special adaptability of a tool or device, he fails to find a man competent to explain it and give such information as he has come to the exposition to get.

Those who will Exhibit, but do not feel so Confident of Results.

Our exhibits at Chicago, Paris, and Glasgow have only brought in small direct results—certainly not enough to warrant the expense. Indirectly we have probably received returns, although it is only our guess.

We regard an exposition in the light of an advertisement, and it goes without saying that all advertisements in trade papers do not bring direct returns to warrant the expense incurred; but for all that, we consider it necessary to advertise, as most of the benefit of our advertising comes indirectly.

We are in doubt as to whether our Paris exhibit brought returns to commensurate expenditures; hard times set in throughout Europe subsequent to the exposition, and this somewhat counteracted the desire to purchase new tools. Did not exhibit at Buffalo. We will exhibit on a large scale in St. Louis, believing the Fair will prove successful in every way.

We exhibited at Paris and were it not for the fact that our machines were grouped with others represented by our agents, thus reducing our expense, we should have considered it quite a failure. If we had not exhibited we think we would have seen no great difference in our sales. It is our intention to exhibit at St. Louis, but our only reason for doing so is that we presume our competitors will be there also.

It is very difficult for us to tell whether or not our exhibits at Paris and Buffalo brought us any returns, or, at least, sufficient to warrant the expense that was incurred. Nevertheless, we have always believed in exhibiting at large expositions, as we secure a large amount of advertising, the results of which are undoubtedly beneficial.

As to whether our exhibits at Paris or Buffalo paid, we say emphatically, No! We look at it in this way: That while it may not pay to exhibit, in a financial sense, and while it may mean a loss in dollars and cents, our wares have an extended sale over an extended area of territory and we feel that we cannot afford not to exhibit.

As to direct results, in the machine tool line, you can hardly expect the exhibit to bring sufficient direct returns to warrant the expense. But on the other hand if you take into consideration the fact that your machines will become better known throughout the country, which will no doubt bring future inquiries and consequently orders, we think the small expense should not be considered.

We believe that all of our exhibits in the various domestic and foreign expositions have paid on the broad ground that advertising pays. We think it would be very difficult for anybody to tell just what he got out of an exposition. We have had trouble about getting our space assigned. In general, expositions are not nearly as good as they would be if space could be given out in ample season so that makers of machinery could have plenty of time to prepare their exhibits.

We must say that we are not very much in favor of expositions, but are rather forced to show our goods, as our competitors always make a good display. We went into the Paris Exposition more on account of our foreign agents, who had, during the previous years, done a very nice business for us. The depression came along soon after this exposition and since then our foreign business has been rather light. It is our intention to make quite a display at St. Louis, for we agree with you that a "dead" exhibit is of no value. We are therefore making preparations to have a large display.

Our exhibit at Buffalo did not bring us sufficient returns to warrant the expense incurred, but it is our intention to exhibit at St. Louis. Under the head of "Remarks," beg to say that a page advertisement in MACHINERY would give better returns than all the expense incurred would bring in exhibiting at one of these expositions, and at a great deal less cost. The reason of our going into these various expositions has been in almost every instance at the very urgent request of our sales agents, but where they have been asked to share the expense, we think they are about as tired of it as we are. We have been in a great many expositions for years past and this has uniformly been our experience.

At the Philadelphia Exhibition our returns, direct and indirect, were very satisfactory, but we were disappointed both in Chicago and Paris. As to St. Louis, we expect to be there; not that we expect it to pay, but because we cannot afford not to be represented. It is a strange fact that nearly all large exhibitions occur at a time when business is dull. At Philadelphia in '76, at Chicago in '93 and Paris in 1900 business was very bad in Europe and there is every probability of the same state of affairs at the time of the St. Louis Exhibition. We think the St. Louis Exhibition is coming too quick after Paris and Buffalo.

It is our intention to exhibit at St. Louis if proper space can be obtained, although our exhibit at Paris did not bring direct or indirect returns enough to warrant the expense incurred. We attribute our failure at Paris, however, to the fact that our officials at Washington have failed to sign a treaty with France that would bring us into closer commercial relations with that country. We have to pay an import duty, as the case now stands, of 3 to 7 cents a pound on machinery that we manufacture, and are thus frozen out of the French market. Another reason for loss at Paris was the exorbitant prices charged by concessioners who had bought the right to furnish the supplies and do the work required by exhibitors.

It is our intention to have space at St. Louis as we had at Paris. We do not consider that a great deal of benefit is derived from these expositions, but they serve as an advertisement, and a few customers may be secured by having machines shown off to good advantage. We recollect one rather peculiar incident in connection with the exposition in 1893 in Chicago, where the writer gave a person a catalog and some eight or nine years later he turned up with the same catalog ready to make purchases to the extent of $2,500 or $3,000, and we secured his entire order; but of course cases like this are rare. We were not benefited greatly by the Paris Exposition, and on this account neglected to have space at the Buffalo Exposition. We understand that manufacturers in general are to go into the St. Louis Exposition with good-sized spaces and we desire to do the same.

We exhibited at Paris, and the total cost, including transportation, etc., was $5,000. We believe that the results would have been better by an expenditure of 10 per cent. of the above amount in advertising in a legitimate trade journal. We were very much disappointed in the business received from our exhibit in Paris. It is our intention to exhibit in St. Louis, provided we can get suitable space and the conditions imposed by the managers are not of such a character as will, in our judgment, interfere with our exhibit. The rumor has reached us that they propose to force all exhibitors to display their respective machines in different groups. If this is true, it will affect us disadvantageously, for we manufacture two distinct lines of machine tools, and if we should thus be obliged to have two men in St. Louis, where one ought to be sufficient, we will probably withdraw our application.

We have had a number of people mention our exhibit in Buffalo and state that they were pleased with what they saw but in most cases they were users of our machines. Exhibiting our product at any exhibition is similar to advertising in your paper or in any other mechanical journal. We feel that there is a limit to this advertising, when the returns are considered. It is a certain amount of money expended in nothing more nor less than advertising, and as you well know, it is rather difficult for us to be sure of the exact results. If we should fail to exhibit, and our competitors should exhibit, we are sure a great many people would be making inquiries as to why we were not there; and the chances are that they would be under the impression that we did not have anything of importance to bring forward, and for this reason did not care to take part. But do you not think that all of the manufacturers in this country should look at this in a broader sense and be willing to send their machinery to this exhibition, if for nothing more than to show the true American spirit? Supposing that manufacturers of all kinds of products should get together and finally decide that they were not sure the returns would be equal to the expenses and fail to send their goods to this exhibition, imagine what a condition this would be, and for this reason I think we should exhibit our machinery at St. Louis, even if our competitors actually failed to do so.

Those who will not Exhibit.

Of the 83 replies received, all from firms who exhibited either at the Paris or Pan-American expositions, or at both of these, as the case may be, 28 do not propose to exhibit at the Louisiana Purchase Exposition, and 12 are still uncertain. In a few instances, as indicated by the extracts from letters below, there are special or individual reasons why they will not take space at the coming exposition, as for example, because the character of the product may not be such as to make a live exhibit possible, except as the tools be shown in connection with other machines; or the diversity of product may be so large that an unusually large and expensive exhibit would be required to make a comprehensive display. The ruling, also, on the part of the exposition managers, that no dealers will be allowed to exhibit, but that all products must be shown by the manufacturers themselves, precludes manufacturers from exhibiting jointly, through some dealer, and thus saving a considerable portion of the expense.

For the most part, however, those who are not to be represented at St. Louis will stay away because they feel that their exhibits at Paris and Buffalo did not net satisfactory results and several express themselves very positively in this respect. One concern writes: "We have failed up to the present time to have received the first indication that either of our exhibits at Paris or Buffalo has done us one cent's worth of good." Another one says: "We are not satisfied that any exhibit we have made has brought sufficient business to pay for the expense and time." Another, "We made a showing at Paris which we have reason to believe was a pretty good one, but we have never been able to see how we have been repaid for the expense we were put to." And another, "Our experience in these matters is such that we are not over-enthusiastic." Several letters of like character were received from those who will not exhibit, which we will not take the space to publish; but below are a few extracts from communications expressing in a more varied manner the opinions of the writers and which are fairly representative of those who will rank among the stay-at-homes in 1904:

We exhibited at Buffalo and it was by all means a very unprofitable venture. It is not our intention to exhibit at St. Louis, owing to the fact that they have laid down very rigid lines which will not enable several of the smaller manufacturers to make a combined exhibit.

It is not our intention at present to exhibit at the World's Fair. It would be expensive, as we would have to maintain the exhibit independently. If we could place our exhibit in the hands of one of our representative dealers in St. Louis, who would exhibit machinery as a dealer, we would no doubt have done so.

We have always felt that in the case of the larger expositions it was a desirable thing to go to them, but this year we have not as yet decided to go to St. Louis and doubt very much if we shall do so. Such an exhibition involves a great deal, not only in the money expense but in the withdrawing from our force some of the best men for a protracted period.

Our experience with such affairs has been rather unfortunate; unprofitable from a business standpoint and unpleasant from a personal view. We believe that one-quarter of the outlay necessary to the installation and maintenance of a proper exhibit, invested in almost any other advertising proposition, and especially used judiciously among the standard trade papers, would produce infinitely better results.

Our exhibits at both the Paris and Buffalo expositions were not productive of business results that would warrant our again taking space in an exposition of like character, although, from the standpoint of "prestige" our results were flattering. For the amount of labor, time and expense involved in preparing and maintaining an exhibit of this kind, we believe the results are inadequate, or, at least, they have been so in our case.

From previous exhibits at expositions we have not received enough results to give us a fair return for the amounts expended. We believe that if we had spent the same amount of money by some other method of advertising it might have brought more returns. Lest this be considered a rather one-sided view, we will say that we believe there is no better way to advertise certain lines of manufacture than by public expositions.

I personally believe that the only persons who make money out of these big expositions are the men who draw salaries from the exposition, and that nine-tenths of the exhibitors net a loss for their trouble. This is from observation rather than from experience, although I have had some unfavorable experience of my own. I have repeatedly written the management of the St. Louis Fair that I considered the managers are the only ones who would be benefited by the exhibit.

Your favor of the 2d is received. We decided after the World's Fair in '93 that it had not paid us, and that we would not go into another American exhibition. There seems to be more effective ways of reaching the home trade for an equal expenditure of money. But we are satisfied with the results of our exhibit at Paris. Europe was a newer territory for us, which it is not so easy to cover by traveling representatives and newspaper advertising.

Our exhibit at the Paris Exposition was absolutely without profit to us. The expense was very great for a concern of the character of ours, not only in the first cost of investment, but in freights, the cost of maintenance, and various incidental items for which only the French know how to charge. A live exhibit at St. Louis would be expensive, and we believe that there is a lull coming in the machine tool trade that will extend over a long period; therefore we think there are other ways of advertising that are more desirable and profitable.

We considered at the conclusion of the Paris Exhibition that we had obtained very little satisfaction as a result of our exhibit. Our trade in France has, however, gradually increased from that time, but it is difficult to determine exactly how much of this trade is due to the Paris Exhibition. Following this we exhibited at Glasgow with very good results. We did not, however, exhibit at Buffalo, and do not propose to exhibit at St. Louis. We consider that the money expended for such exhibits in this country can be applied to better advantage in other ways.

We went to considerable expense in making and maintaining an exhibit at the Paris Exposition, but have been unable to trace any returns that would in any way warrant the expense incurred. We look at these expositions as a rather expensive means of advertising, and so far as we are able to judge it is one of the means of advertising that does not pay us, for our tools are of such a character that they must be shown in connection with other machines to be operative. Many of our tools are shown by the manufacturers of such machines, applied to the machines, where they can best be shown.

Those who are Uncertain.

As stated above, 12 of the concerns heard from in reply to our circular letter had not at the time of writing decided whether they would exhibit, the reasons for the most part being that their previous exhibits had not paid and their hesitancy in the matter springing, evidently, from a feeling that it might be a mistake not to exhibit, in spite of the expense, as long as competitors were to have displays. A few of the letters from such firms are quoted from below. Inasmuch, however, as there are more applications for space in the machinery building than there is space to be had, it is probable that these 12, or most of them, at least, can be counted with the 28 who will not exhibit.

The Pan-American exhibit brought noticeable direct and indirect returns. An exposition is an advertisement, but we doubt, however, whether the expense was as profitable as though it had been incurred through other channels.

We are hesitating about arranging for any exhibit at the St. Louis Exposition, as we have seen no direct results from other exhibits of like kind. We believe if the same amount of money necessary to make a good display should be used in having travelers make personal calls on the trade, that far better results would be obtained.

Our experience has not been very satisfactory at previous expositions, and it is a question whether we will exhibit at St. Louis. Our direct sales at Paris probably paid the expense of the exhibit; and of course we got more or less advertising from same; but in a general way we do not think that exhibits of this kind bring direct returns enough to warrant the expenditure of both time and money.

Our impression is that we have not from a financial point of view received any great benefit either directly or indirectly from exhibits. The great majority of people who visit these fairs are not looking for business; they simply glance at what they see in passing by, and at the World's Fair it seemed to the writer that the most interest taken in general manufacture, or goods of a general character, was manifested by foreigners, largely German and Japanese.

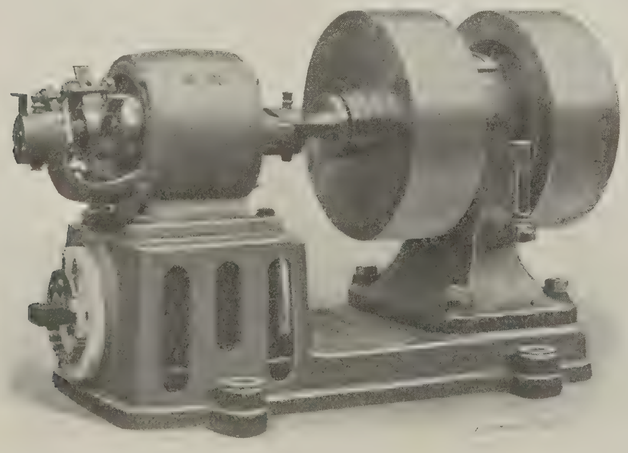
We do not feel very enthusiastic about going to St. Louis and it is uncertain whether we do so. We have exhibited in all of the principal expositions since 1873, and are unable to say whether they ever did us any good or not. The expense increases at every exposition that is held, and in our opinion the showing of goods is growing less valuable at such places, for the reason that people are getting tired of them. The first one or two expositions attracted a great deal of attention, but the interest in them is dwindling away, and it is our opinion that the principal part of the exhibitors take their wares to an exposition because they feel almost forced to do so.

* * *

A NEW GERMAN ELECTRICAL OIL-TESTING APPARATUS.

FRANK C. PERKINS.

It is very necessary where apparatus is in operation continuously and at medium or high speeds that the highest grade of lubricating oil be used. In large shops, power plants and factories where a considerable quantity of oil is required it is very desirable before purchasing to thoroughly test the oils both in order to find out the most desirable oil for the particular apparatus in use as well as to determine whether subsequent shipments are up to the standard determined upon.



Oil-testing Device, Electrically-driven.

A new electrically operated oil testing apparatus has recently been brought out by the Elektricitats-Actien-Gesellschaft, formerly W. Lahmeyer & Co., of Frankfort-on-the-Main, Germany, which is of more than passing interest. It is possible with this oil tester to accurately determine the frictional coefficient of different grades of oils at varying temperatures. It consists of a short length of shaft running in a bearing of the ring-lubricated type, and carries a heavy flywheel at each end which produces the ordinary pressure on the bearing.

A pin coupling is provided on this shaft in order that the motive power can be uncoupled at any moment while running. The apparatus is designed to be driven by an electric motor, by mechanical means or by hand. For laboratory purposes the machine is arranged with flywheels for different bearing pressures and an exact device for measuring the speed. The apparatus when electrically driven as noted in the accompanying illustration is equipped with a motor having an output of about 1-6 of a horse power, which operates at a speed of 1,800 revolutions per minute. The motor is set upon a common base plate with the oil testing machine and drives the latter by means of a pin coupling.

The machine, when mechanically operated and driven by belt, is of similar construction, having a suitable coupling for disengaging the motive power at the proper time. When the oil testing machine is hand driven, two small reduction gear spindles are arranged so as to obtain a speed of from 1,500 to 1,700 revolutions per minute at the flywheel spindle, a similar uncoupling arrangement being also provided as above.

When testing a sample of oil about one-half a pint of the lubricant is placed in the bearing and the motor is started, the flywheel shaft being run at full speed for a short time, when the motor is disconnected by means of the coupling, allowing the tester to continue running until it comes to rest. It is only necessary to note the time required for the apparatus to come to rest in order to compare the lubricating qualities of the various samples, the better the quality of the oil, of course, the longer the shaft will run before coming to rest.

When another sample of oil is to be tested, benzine is passed through the bearing in order to thoroughly clean it, and a blast of air is allowed to pass through as well, to dry it out, thus obviating the necessity of taking the apparatus apart. This method of cleaning has been found to work with perfect satisfaction after many trials of both ways.

This electrical testing apparatus is fitted with electrical resistance coils for warming the bearing to any desired temperature. A wide range of regulation can be obtained, and the frictional coefficient of various classes of oils can be tested under normal conditions of working of different types of machines.

With the mechanically driven oil testing machine, tubes are provided in the oil reservoir, through which hot water may be passed and these tubes can also be used for cooling by passing cold water through them at any desired temperature.

A method of determining whether or not the oil is likely to solidify, is to place the lubricant to be tested between two polished iron plates and laying them together, when it will be found that if the oil is at all likely to solidify it will be difficult to move the plates against one another after a short time has elapsed.

In order to test the oil to determine whether it is free from acid, it is only necessary to dip a polished copper plate into the sample for a short period of time, and note whether there is any difference between that part of the plate which was in contact with the oil and that which was not immersed.

* * *

In an article on safety mining lamps, published in the *Journal of the Franklin Institute*, Mr. Rufus J. Foster gives a history of the various schemes of lighting used in gaseous mines. Candles and various forms of lamps were early used for lighting mines, but, of course, these could not be used when the workings became foul. Under such conditions the skins of putrid fish were sometimes hung up close to the face of the coal. The slight phosphorescence of the skins enabled the miner to barely see the outlines of his work. Not so repulsive, and more interesting, were the "steel mills" used for lighting mines. These crude devices consisted of a steel wheel mounted on a shaft carrying a small pinion. Meshing with this pinion was a larger gear wheel operated by a crank, the whole being mounted in a light frame so that the machine could be easily carried about. A boy vigorously turned the crank with one hand while with the other a piece of flint was pressed against the side of the steel wheel. The result was a shower of sparks having a very slight illuminating effect, being dangerous to boot. Several disastrous mine explosions are recorded which resulted from the use of the mills. The invention of the Davy safety lamp in 1815 is one of the great benefits conferred on humanity by the inventor. It has saved countless thousands of miners' lives and made the operation of gaseous mines possible that without the Davy lamp could not be worked at all.

THE POOLE WORM-DRIVEN BORING MILL.

The half-tone, Fig. 1, illustrates an 8-foot boring mill which is one of a new line of machines that has recently been brought out by The J. Morton Poole Co., Wilmington, Del. These machines have been designed for the heavy duty that is required by the use of high-speed tool steels, and although the machine shown is belt-driven, provision has been made for the application of any make of motor without encroaching upon valuable floor space or bolting unsightly brackets to the bed or uprights.

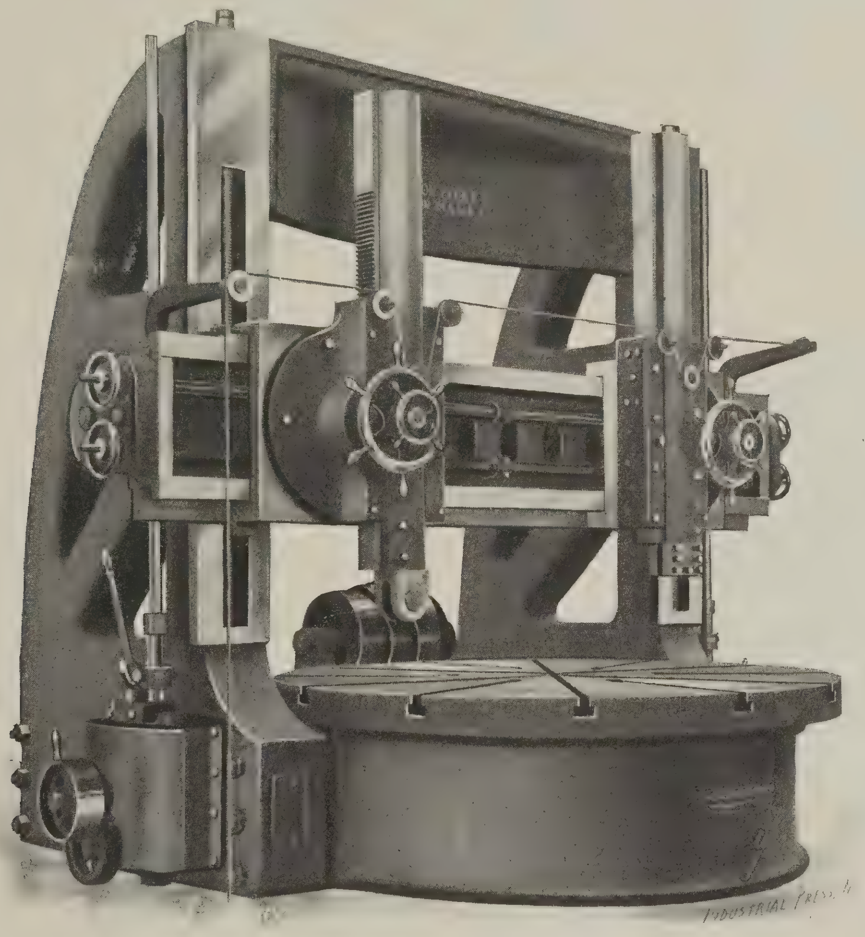


Fig. 1. J. Morton Poole Boring Mill.

The table rests upon wide flat bearings at its extreme outer edge, and is driven by a powerful "Hindley" worm wheel which is mounted on the spindle between the upper and lower bearings. This method of placing the worm wheel on the spindle, enables the operator to elevate the table from its outer bearings and take the thrust on the spindle step bearing, when running at high speeds, without destroying the alignment of the worm and wheel. The driving worm runs in an oil chamber in the bed and the table bearing is automatically lubricated by rollers located in oil pockets and held up against the bearing surface by springs.

The arrangement of the worm gear and driving mechanism is clearly shown in Fig. 2. The worm wheel, which, on this size of mill is 64 inches in diameter, has 96 teeth of 2-inch pitch. The worm, having 8 threads, thus provides a 12 to 1 gear reduction. The gears, *G* and *H*, are keyed to the back gear shaft and drive the loose friction gears, *A* and *E*. The chain gear, *T*, runs loose on the back gear shaft and carries the pinion *L*, which drives the back gears, *U*, *S*, and *R*, the latter running loose on the shaft. The chain gear can drive the back gear shaft direct, by operating the friction clutch between *G* and *T*, or a back gear ratio of 8 to 1 can be obtained by engaging the clutch, *O*, which is keyed to the shaft with the hub of gear *R*. The cone pulley has three steps for 6-inch belt, and a 3-inch Morse silent chain transmits the power from the cone shaft to the back gear shaft. This arrangement of gearing gives back gear ratios of 12, 36, 95, and 285 to 1. When a two-speed friction countershaft and three-step cone pulley are used, 24 table speeds are available, and either series of eight speeds can be obtained without shifting the belt or stopping the machine. The various speeds are obtained by a lever and hand wheel conveniently located at the right of the machine.

In Fig. 3 is shown the feed box with the cap removed. On each end of the main worm shaft is a feed worm, *B*, driving the worm wheel, *C*, which is keyed to the hub of the pinion *D* running loose on the shaft. Gear *F* is also loose on the shaft and is driven from *D* through the gears *I* and *J*, which are loose on the other shaft and give a feed back gear of 8 to 1. Either *D* or *F* can be engaged with the shaft by means of a sliding key operated by the lever *B'* upon shaft. Gears *K*, *M*, *N*, and *P* are keyed to the shaft and drive the four loose gears, *Q*, *V*, *W*, and *X*; any one of which, or the rapid traversing spiral gear, *Y*, can be engaged with the shaft by the lever *C'* and a sliding key running in a slot in the shaft. Spiral gear *Y* is driven at a constant speed, through the gear *Z* and the shaft *A'* by the pulley and gears shown at the left of the machine in Fig. 1. By these various combinations of gears we may obtain 8 feeds from 1-64 to ¾ inch, and a quick traverse of the crossheads in or out, and the tool bars up or down, at a rate of 8 or 13 feet per minute, and it is impossible to throw in any of the feeds while traversing. The feeds and traversing speeds are reversed in the gear boxes on the ends of the cross rail, by means of small hand wheels. Both feeds and speeds of each head are entirely independent and can be applied at any angle at which the swivel heads may be set.

A lever in front of the right-hand upright controls a friction clutch for elevating and lowering the cross

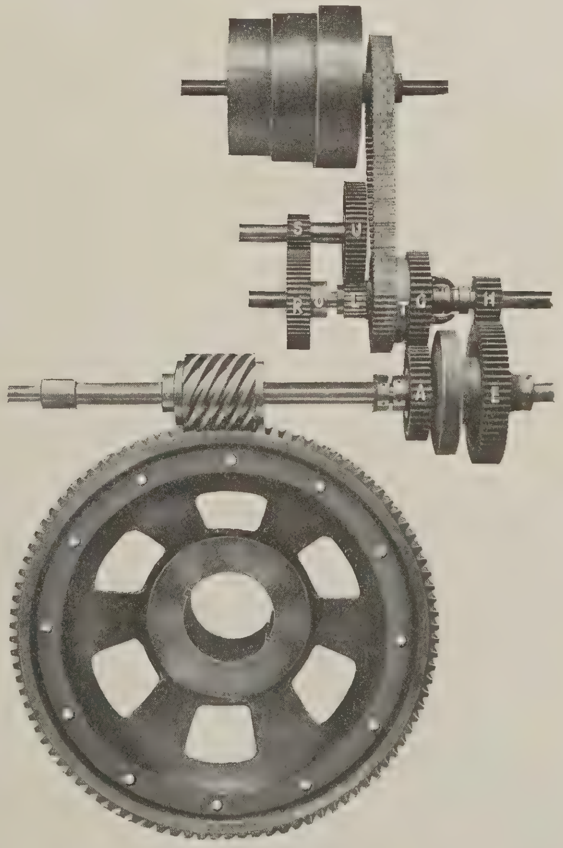


Fig. 2. Worm Drive for Table, with Morse Chain and Gear Connections.

rail at a rate of 4 or 7 feet per minute, and this arrangement dispenses with the usual pulley, bevel gears, brackets and shaft that are generally placed on the top of a boring mill. The usual chain connection for the tool slide counterbalance has also been replaced by a wire rope.

When it is desired to make the machine motor-driven, a small constant speed motor is attached to the left upright for the power traveling of the heads, tool bars and cross rail, and a variable speed motor is bolted to the bed in place of the cone pulley, shaft and brackets. A silent chain pinion, of the proper size to give the correct back gear speed, is keyed to the motor shaft and the rest of the driving mechanism remains exactly as illustrated for the belt drive.

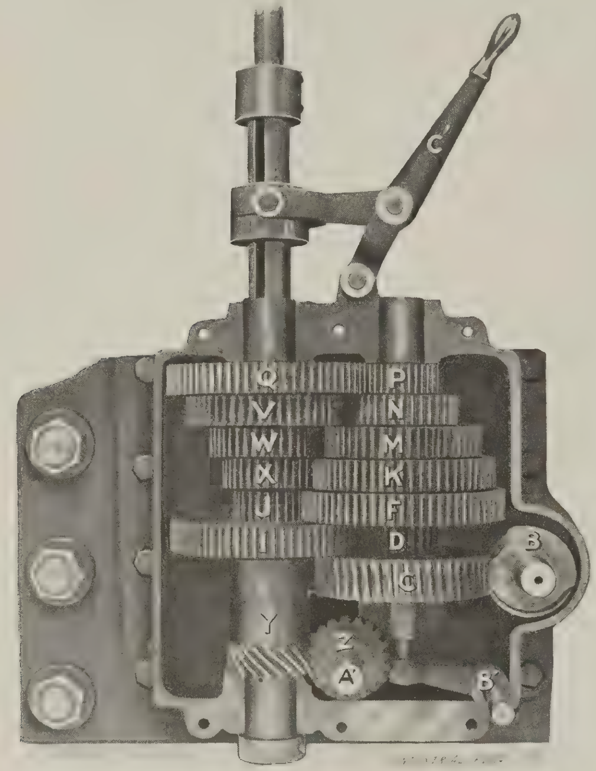


Fig. 3. Feed Box for Boring Mill.

* * *

Mr. W. P. Atwell, the U. S. consul at Roubaix (in Northern France) says that American machinery and labor-saving tools are making great headway in that great industrial district. American agricultural machinery, tools, etc., are being used extensively and with great success. There is a large demand in the district for all kinds of American machinery, tools, hardware, typewriters, desks, farming implements, stoves, motor cars, bicycles, novelties, etc. The sales of such goods should be intrusted to general agents who understand the language and trade methods of the French. Printed advertising matter is useless unless printed in French. Goods should be securely packed, and all weights and measures should be quoted in the metric system. German imitations of American machinery are sold there as the genuine, but at very low prices.

* * *

In a little periodical called *The Corbin*, issued in the interests of a lock-making concern, a small East Indian padlock was recently illustrated and described. To unlock it requires four distinct operations. First, a thumbscrew has to be turned by which a bail is drawn down revealing a hole into which a screw-bitted key is inserted and turned until a spring throws back a front plate and reveals the keyhole. Two keys are required to unlock, one being inserted after the other and each drawing a separate bolt. The locking is the reverse of this tedious operation which leads the writer of the description to remark: "The lock is an ingenious one and may answer in a land where time is reckoned by centuries and an hour is a mere nothing, but in this country of the split-second watch and mile-a-minute train, the ordinary citizen has no time to spend in turning three keys and a thumbscrew to open a single lock. He would be likely to use an axe instead."

BOILER BRACING.—2.

CALCULATIONS FOR THROUGH STAYS.

CHARLES L. HUBBARD.

High pressure boilers and those of large size are usually provided with through braces. Sometimes two or three through braces are placed in line across the head, a short distance above the tubes, and the upper part of the segment is supported by crow foot braces. When through braces are used in the upper part of heads they interfere seriously with the inspection of the boiler. Aside from this, the method of through bracing is preferable to any other, as it does away with all pins or bolts. The braces are straight steel rods, without welds, and an even tension can be secured upon all of the braces, which is very difficult, if not impossible, in the case of diagonal braces. For boilers 66 and 72 inches in diameter, five through braces may be used, and, if properly spaced, allow sufficient room for inspection. Boilers 60, 54 and 48 inches in diameter may have a combination of through and crow foot bracing. Below 48 inches they are mostly used for heating purposes or for running small engines at comparatively low pressures, and crow foot bracing will be found sufficiently strong. Through bracing consists of rods passing through the entire length of the boiler, with heavy nuts and washers at the ends on the outside, and check nuts on the inside. Stiffening pieces of channel or angle iron are riveted to the heads to support them.

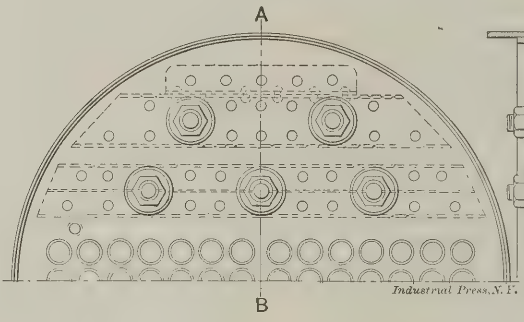


Fig. 1.

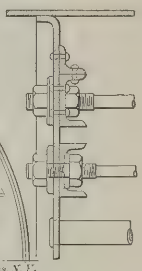


Fig. 2.

Fig. 1 shows the general arrangement of the channels and braces, and Fig. 2 a section on line *A B*. The upper bar in this case consists of a channel iron with an angle riveted to its upper flange to give it greater strength. The lower bar is made up of two angles riveted to the head, as shown.

Where angles are used instead of a channel, it is necessary to countersink slightly around the holes for the braces, to give a solid bearing for the washer and check nut. The outside washer is sometimes made of copper slightly cup-shaped on the under side in order to give a tight bearing around the edge. It is more common, however, to use heavy cast-iron washers and embed them in red lead to make them tight. When channel bars will give the required strength, they are preferable to angles for stiffening pieces, but for high pressures the standard weights will, in many instances, be found too light, and resort must then be made to angle irons, of which there is a great variety of sizes and weights to choose from. In this form of bracing the channel bars act as beams, carrying the loads due to the pull on the rivets, and the beams in turn are supported by the rods. The general method of designing through bracing, which is given here, can be found in "Steam Boilers," by Professors Peabody and Miller. We shall take it up here more in detail in order to refreshen the

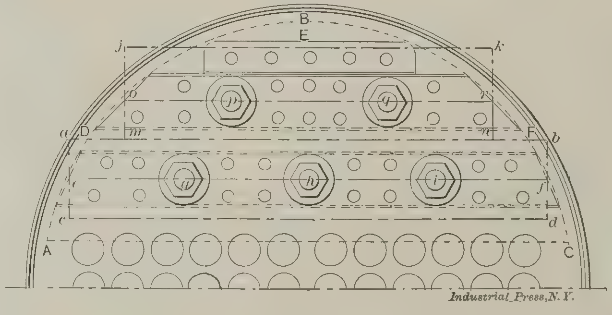


Fig. 3.

reader's mind on certain points which come more strictly under the head of mechanics. Referring to Fig. 3, let us take up the different steps in detail. The area to be supported is found in the way already described in a previous article and is shown by *A*, *B* and *C*. The rivets for fastening the head to the channel bars are laid out as nearly as possible in equi-distant rows; the maximum distance between them being checked by the formula already given for this purpose. In practice they are usually placed from 4 to 5 inches apart. The load carried by each rivet is then computed the same as for crow foot bracing, and the size is made such that the stress shall not be more than 6,000 pounds per square inch. No rivet should be placed nearer than 3 inches to the shell or tubes on account of the straining effect due to expansion. Channel bars of suitable width are then drawn in, and the stays, usually five in number, are laid out, leaving sufficient space (not less than 19 or 20 inches) between the two upper ones for access to the boiler.

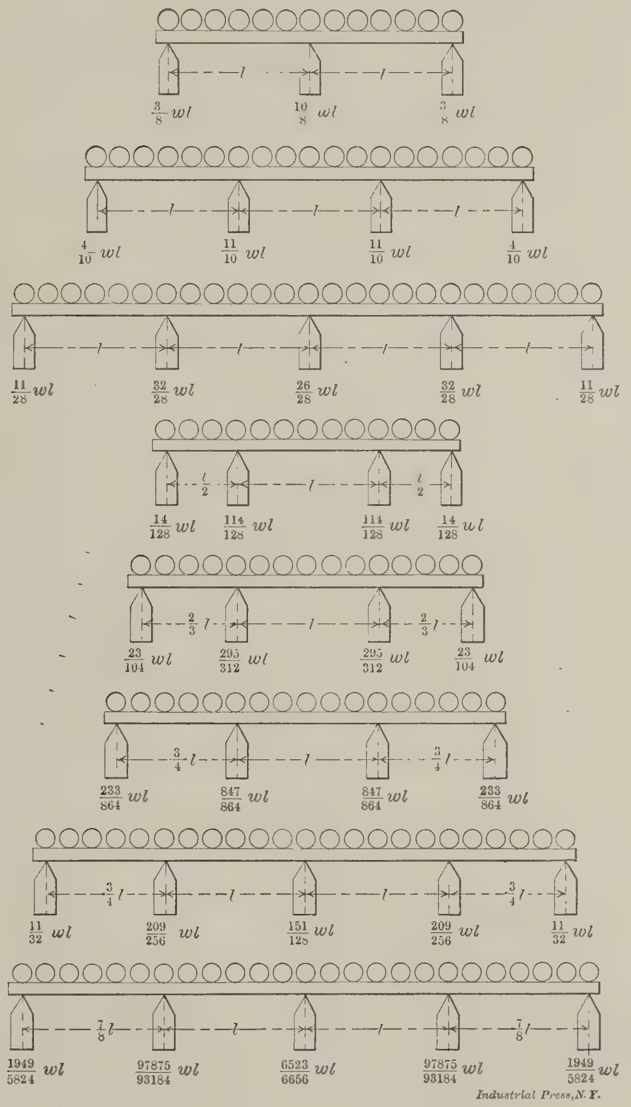


Fig. 4.

It is common to use 7-inch channels, or their equivalent, in angles, for 72 and 66-inch boilers; 6-inch channels for 60 and 54-inch boilers, and 5-inch for 48-inch boilers. It is only necessary to assume a width at this stage of the problem in order to arrange the rivets and stays; the weight of the bars can be computed later. The next step is to determine the required size of the stays or braces. The area to be supported by the lower stays may be taken as that of a strip or rectangle bounded on the bottom by the line *c d*, half way between the lower line of rivets in the lower channel and the line *A C*, and bounded at the top by the line *a b*, half way between the lower rivets in the upper channel and the upper rivets in the lower channel.

The ends of the rectangle are formed by the vertical lines *a c* and *b d* drawn through the extremities of the center line of the channel at *e* and *f*. This strip is commonly provided with three stays in boilers from 54 to 72 inches in diameter, and with two in 48-inch boilers, although different engineers may vary this arrangement somewhat.

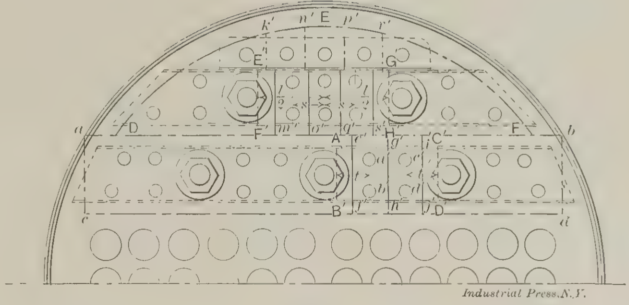


Fig. 5.

The strip may now be treated as a continuous girder. Where a uniformly loaded beam passes over more than two supports, the rules applying to simple beams no longer hold, as new forces and conditions are introduced. By a somewhat complicated process, values have been computed for the loads acting on the various supports for different arrangements of spacing. These results are shown in the diagrams, Fig. 4.

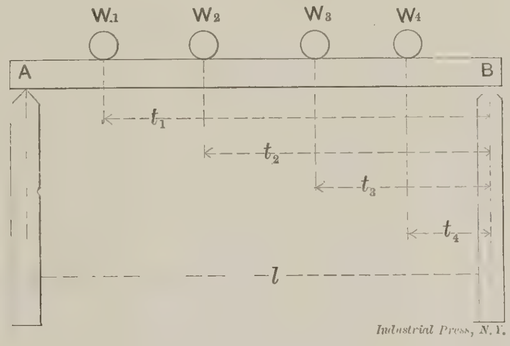


Fig. 6.

In all cases *w* is the load per unit of length; that is, if *l* is taken in inches; then *w* is the load per inch in length of the beam, and equals, of course, the total load divided by the length of the beam.

Referring to Fig. 4 we find for the case of a continuous girder with five equally spaced supports, that the greatest loads are carried by those next to the ends and are equal to $\frac{32}{28} w\,l$ pounds each. *w* being the load per unit length, is evidently equal to the width of the strip in inches multiplied by the boiler pressure per square inch, and *l* is the distance, *eg*, *gh*, etc., between the supports in inches. Having found the greatest load carried by any of the lower stays we then proceed to do the same for the upper ones before calculating the required size.

TABLE I.

Diameter of Rod.	Area of Section in inches.	Weight of Rod per foot.	Diameter of Upset Screw Ends.	Threads per inch.	Thickness of Nuts.
$\frac{3}{4}$	.4418	1.47	1	8	$\frac{3}{4}$
$\frac{13}{16}$	.5185	1.72	$1\frac{1}{8}$	7	$\frac{7}{8}$
$\frac{7}{8}$	.6013	2.00	$1\frac{1}{4}$	7	$\frac{7}{8}$
$\frac{15}{16}$	.6903	2.30	$1\frac{1}{4}$	7	1
1	.7854	2.61	$1\frac{3}{8}$	6	1
$\frac{1}{8}$	.9940	3.31	$1\frac{1}{2}$	6	$1\frac{1}{8}$
$\frac{1}{4}$	1.227	4.09	$1\frac{5}{8}$	$5\frac{1}{2}$	$1\frac{1}{4}$
$\frac{3}{8}$	1.484	4.95	$1\frac{3}{4}$	5	$1\frac{3}{8}$
$\frac{1}{2}$	1.767	5.89	2	$4\frac{1}{2}$	$1\frac{1}{2}$
$\frac{5}{8}$	2.073	6.91	$2\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{5}{8}$
$\frac{3}{4}$	2.405	8.01	$2\frac{1}{4}$	$4\frac{1}{2}$	$1\frac{3}{4}$
$\frac{7}{8}$	2.761	9.20	$2\frac{3}{8}$	$4\frac{1}{2}$	$1\frac{7}{8}$
2	3.141	10.47	$2\frac{1}{2}$	4	2
$\frac{1}{8}$	3.546	11.82	$2\frac{5}{8}$	4	$2\frac{1}{8}$
$\frac{1}{4}$	3.976	13.25	$2\frac{7}{8}$	4	$2\frac{1}{4}$
$\frac{3}{8}$	4.430	14.77	3	$3\frac{1}{2}$	$2\frac{3}{8}$
$\frac{1}{2}$	4.908	16.36	$3\frac{1}{8}$	$3\frac{1}{2}$	$2\frac{1}{2}$
$\frac{5}{8}$	5.411	18 04	$3\frac{1}{4}$	$3\frac{1}{2}$	$2\frac{5}{8}$
$\frac{3}{4}$	5.939	19.80	$3\frac{3}{8}$	$3\frac{1}{2}$	$2\frac{3}{4}$
$\frac{7}{8}$	6.491	21.64	$3\frac{5}{8}$	$3\frac{1}{4}$	$2\frac{7}{8}$

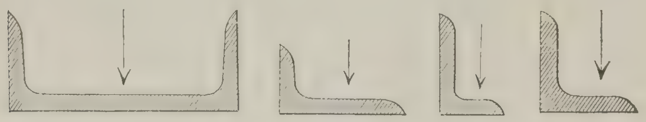
The area to be supported by the upper stays is that of the segment, *D B F*; This area may be computed by the rule already given. Next construct a rectangle by drawing vertical lines *j m* and *k n* through the extremities of the center line of the upper channel, at the points *o* and *r*, making the height *j m* such that the area shall equal that of the segment just found. Treat this as a continuous girder with four supports. If the stays are spaced so that the distance *o p* equals two-thirds of *p q*, then we shall find from Fig. 4 that the greatest loads are carried by the supports at *p* and *q*, and are each equal to

$$\frac{295}{312} w l,$$

in which *w* equals the width *j m* of the rectangle multiplied by the boiler pressure, and *l* is the distance *p q*.

TABLE II: GIVING PROPERTIES OF CHANNELS AND ANGLES.

[In the following are the moments of resistance and other properties for different sizes and weights of channels loaded as shown in the accompanying sketches.]



CHANNELS.

Size.	Width of Flange.	Thickness of Web.	Weight per foot.	Moment of Resistance.
7	2 09	.21	9.75	.63
7	2.19	.31	12.25	.71
7	2.46	.36	14 75	1.03
7	2.56	.46	17.25	1.13
7	2.67	.57	19.75	1.23
6	1.92	.20	8.00	.49
6	2.14	.27	10.50	.68
6	2.27	.40	13.00	.78
6	2.39	.52	15.50	.88
5	1.75	.19	6.50	.37
5	1.88	.32	9.00	.46
5	2.03	.47	11.50	.53
4	1.58	.18	5.25	.29
4	1.64	.24	6 25	.32
4	1.72	.32	7.25	.35

ANGLES WITH EQUAL LEGS.

Size.	Thickness.	Weight per foot.	Moment of Resistance.
$3\frac{1}{2} \times 3\frac{1}{2}$	$\frac{13}{16}$	17.1	2.25
$3\frac{5}{8} \times 3\frac{5}{8}$	$\frac{5}{8}$	13.7	1.84
$3\frac{3}{16} \times 3\frac{3}{16}$	$\frac{5}{8}$	11.5	1.39
3×3	$\frac{5}{8}$	11.4	1.30
$3\frac{1}{2} \times 3\frac{1}{2}$	$\frac{3}{8}$	8.5	1.15
3×3	$\frac{1}{2}$	8.6	1.02
$3\frac{1}{2} \times 3\frac{1}{2}$	$\frac{5}{16}$	7.1	.98
$2\frac{3}{4} \times 2\frac{3}{4}$	$\frac{1}{2}$	8.5	.89
$2\frac{5}{8} \times 2\frac{5}{8}$	$\frac{1}{2}$	7.8	.75
$2\frac{1}{2} \times 2\frac{1}{2}$	$\frac{1}{2}$	7.7	.73
3×3	$\frac{1}{4}$	4.9	.58
$2\frac{1}{4} \times 2\frac{1}{4}$	$\frac{1}{2}$	6.8	.58
$2\frac{7}{16} \times 2\frac{7}{16}$	$\frac{3}{8}$	5.4	.50
$2\frac{3}{4} \times 2\frac{3}{4}$	$\frac{1}{4}$	4.5	.48
$2\frac{1}{2} \times 2\frac{1}{2}$	$\frac{1}{4}$	4.1	.40
$2\frac{3}{16} \times 2\frac{3}{16}$	$\frac{3}{8}$	4.8	.40
2×2	$\frac{7}{16}$	5.3	.40
$2\frac{1}{4} \times 2\frac{1}{4}$	$\frac{1}{4}$	3.7	.32
$2\frac{1}{2} \times 2\frac{1}{2}$	$\frac{3}{16}$	3.1	.30

ANGLES WITH UNEQUAL LEGS.

Size.	Thickness.	Weight per Foot.	Moment of Resistance, Load Perp. to Longer Flange.	Moment of Resistance, Load Perp. to Shorter Flange.
$4 \times 3\frac{1}{2}$	$\frac{13}{16}$	18 5	2.30	2.92
$3\frac{1}{2} \times 3$	$\frac{13}{16}$	15.7	1 65	2.20
$3\frac{3}{16} \times 3\frac{5}{16}$	$\frac{5}{8}$	12.9	1.53	2.00
$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{11}{16}$	12.4	.99	1.85
$3\frac{3}{4} \times 2\frac{3}{4}$	$\frac{1}{2}$	9.4	.88	1.58
$4 \times 3\frac{1}{2}$	$\frac{3}{8}$	9.1	1.18	1.50
$4 \times 3\frac{1}{2}$	$\frac{5}{16}$	7.7	1.00	1.27
$3\frac{1}{4} \times 2\frac{3}{4}$	$\frac{1}{2}$	8.7	.88	1.20
$3 \times 2\frac{1}{2}$	$\frac{9}{16}$	9.5	.82	1.15
$3\frac{5}{8} \times 2\frac{1}{8}$	$\frac{3}{8}$	6.6	.41	1.09
3×2	$\frac{1}{2}$	7.7	.47	1.00
$3\frac{1}{2} \times 3$	$\frac{5}{16}$	6.6	.72	.96
$2\frac{13}{16} \times 2\frac{15}{16}$	$\frac{1}{2}$	7.0	-60	.88
$3\frac{1}{2} \times 2\frac{1}{2}$	$\frac{1}{4}$	4.9	.41	.75
$3\frac{1}{2} \times 2$	$\frac{1}{4}$	4.5	.27	.72
$2\frac{1}{2} \times 2$	$\frac{1}{2}$	6.8	.46	.70
$2\frac{1}{4} \times 1\frac{1}{2}$	$\frac{1}{2}$	5.5	.26	.59
$3 \times 2\frac{1}{2}$	$\frac{1}{4}$	4.5	.40	.56
3×2	$\frac{1}{4}$	4.1	.26	.54
$2\frac{7}{16} \times 1\frac{11}{16}$	$\frac{3}{8}$	4.4	.24	.46

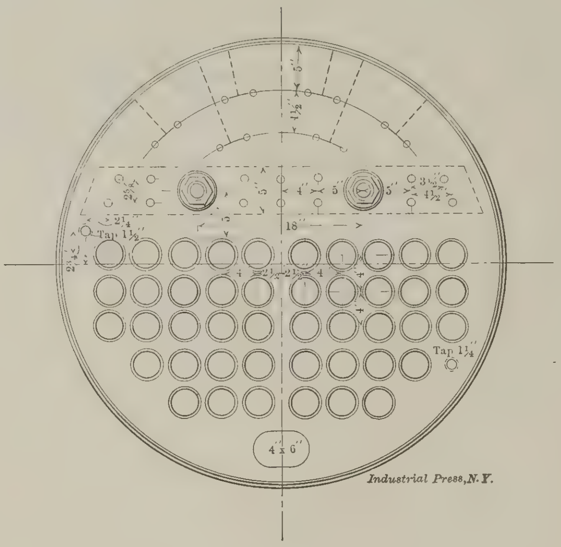


Fig. 7. Forty-eight inch Boiler.

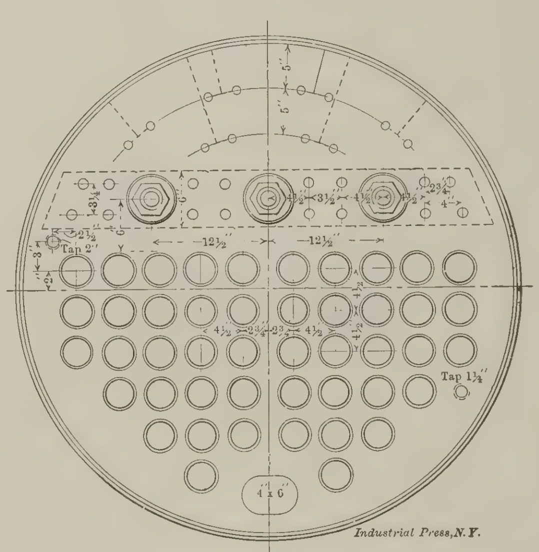


Fig. 8. Fifty-four inch Boiler.

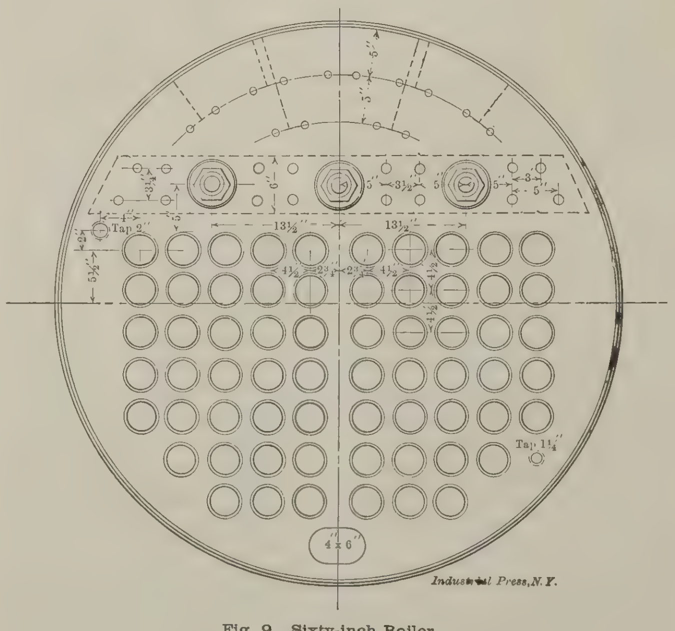


Fig. 9. Sixty-inch Boiler.

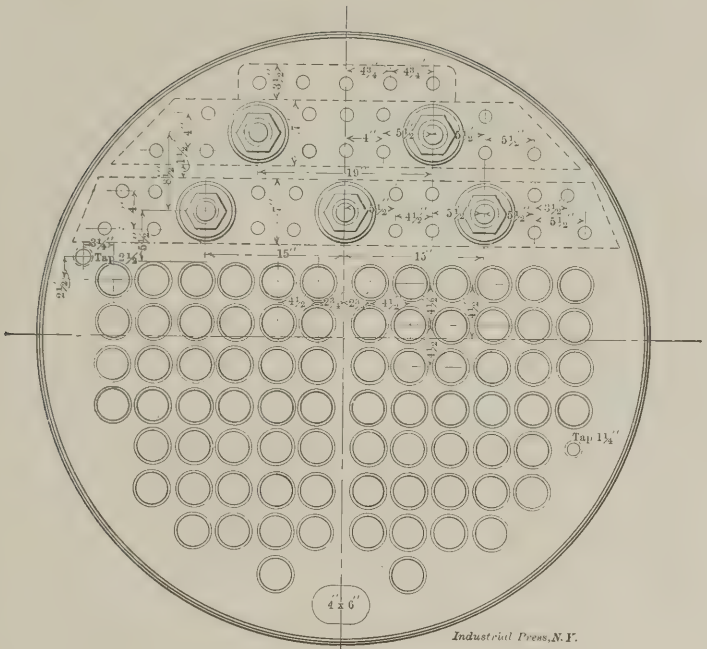


Fig. 10. Sixty-six inch Boiler.

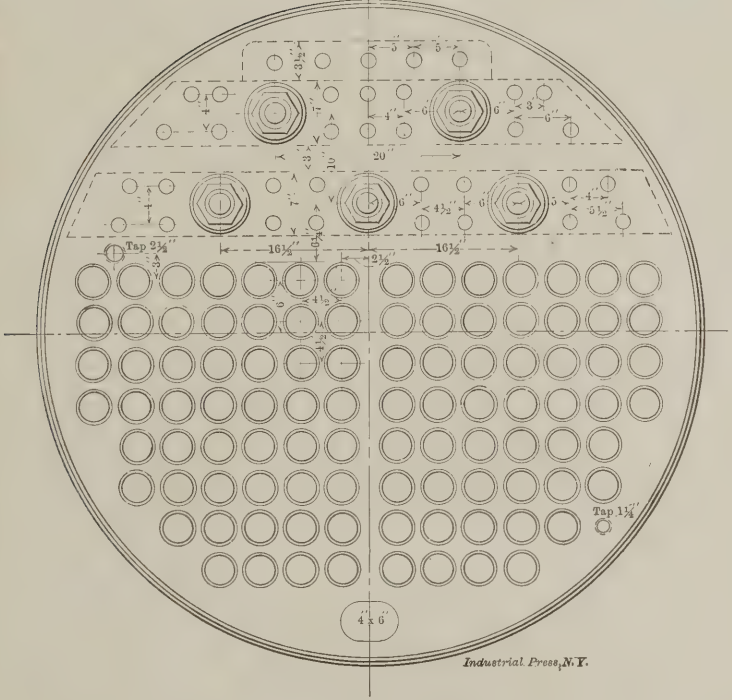


Fig. 11. Seventy-two inch Boiler.

In computing the required size of the stays we may allow a stress of 10,000 pounds per square inch for mild steel. By taking the greatest load found for any one stay and dividing it by 10,000, we have the required area of section in square inches, and the corresponding diameter can be found at once from a table of areas. The ends of the stays should be upset so that the diameter at the root of the thread shall be as great or greater than the body of the stay. If an allowance is to be made for corrosion it can be added directly to the diameter thus found. The working load is sometimes fixed by government rules or by insurance companies, and may vary somewhat from the above, but the method of computation will be the same in any case.

Table 1 will be found useful in proportioning the stays, nuts, etc.

In computing the required strength of the lower channel the maximum bending moment must first be found. This is done by taking a section of the bar, cut by the lines *A′ B′* and *C′ D′* (Fig. 5), drawn ¼ the diameter of the large washers from their centers, and treat it as a simple beam supported at both ends and carrying two loads symmetrically placed. The loads are each equal to the area supported by a pair of rivets, multiplied by the boiler pressure per square inch. The area supported by a pair of rivets, as *a′ b′*, is taken as that bounded by lines drawn half way between the rivets and the adjacent points of support, for example, *e′ g′* is half way between the upper line of rivets in the lower channel, and the lower line in the upper channel, and *g′ h′* is half way between the rivets *a′ b′* and *c′ d′*, etc. In the case of a beam loaded as above, the maximum bending moment $M = \frac{Wt}{2}$, in which $\frac{W}{2}$ is the load on a pair of rivets, and t is the distance of the rivets from the line of support, *A′ B′*.

Having determined the value of M for any given case, the "moment of resistance" can be found from the relation $\frac{M}{f}$ = moment of resistance, in which f is the safe working stress in the outer fibers of the beam. In the case of rolled steel beams used in this manner it is common to assume a safe working stress of 16,000 pounds per square inch.

In the case of the upper bar the channel and angle iron are riveted together and treated as a single beam supported at both ends and having three loads symmetrically placed. Under these conditions the maximum bending moment,

$$M = \left(\frac{l}{2} \times \frac{W}{2}\right) - (s \times w) \text{ in}$$

which W = the total load, which is equal to the area *m′, k′, r′, s′*, multiplied by the steam pressure per square inch, w = the load on area *q′, p′, r′, s′*, l = the distance between the points of support or the distance between lines *E′ F′* and *G′ H′*, s = the distance between the rows of rivets as shown.

The supporting lines *E′ F′* and *G′ H′* are drawn ¼ the diameter of the large washers from their centers and the loads as before are taken as equal to the area supported by a vertical row of rivets, multiplied by the boiler pressure. The supported areas are divided by lines drawn half way between the points or lines of support, as already described. The moment of resistance is computed from the bending moment and suitable sizes of channel and angle bars are selected and riveted together to give the required strength.

If the required moment of resistance is greater than any found in the table for channels the bars must be made up of angles taken from Table II.

In case the rivets in either the upper or lower channel are not symmetrically placed, the position and amount of the maximum bending moment may be found as follows, by comparing it with a beam with any number of loads *not* symmetrically placed.

Knowing the weights of the loads, W_1, W_2, W_3, etc., in Fig. 6, the first step is to determine how the total load is divided between the points of support, *A* and *B*. This may be done by considering the beam hinged at one end, as at *B*, and carrying the loads W_1, W_2, W_3, etc., with a resisting force or support at *A*. As the bar remains stationary, it is evident that the forces tending to rotate it in one direction about *B* must be just equal to those acting in the opposite direction. In other words, the moment $Al = W_1t_1 + W_2t_2 + W_3t_3 + W_4t_4$, from which equation the value of the force represented by *A* can easily be found. Knowing the resisting force at *A*, that at *B* can be found by subtracting *A* from the total load. To find the point where the maximum bending moment occurs, begin at *B* and take the sum of the loads, $W_4 + W_3$, etc., until a quantity is obtained which is equal to, or greater than, the resistance just found at *B*. The point at which this last load acts is the position of the maximum bending moment. For example, suppose $W_4 + W_3$ is less than *B*, and $W_4 + W_3 + W_2$ is greater, then we know the greatest bending moment occurs at W_2, or strictly speaking, somewhere between W_3 and W_2. Taking the sum of the moments about W_2, we have for the value of the maximum bending moment a quantity $= Bt - [W_3\ (t_1 - t_3) + W_4\ (t_2 - t_4)]$.

Figs. 7, 8, 9, 10 and 11 give detail drawings of boilers of various sizes designed by the foregoing methods to carry a working pressure of 100 pounds per square inch, and will be found useful for comparison in the design of new work. It has been assumed in all cases that the heads are not less than ½ inch in thickness.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The steamship *Deutschland* broke all ocean records when she reached Quarantine in New York Harbor, September 8, having made the westward trip in 5 days, 11 hours and 54 minutes. This beats her best previous run by 69 minutes and the best record of the *Kronprinz Wilhelm* of the North German Lloyd line, by 3 minutes.

On July 14, 1903, the Great Western Railway made a record run from Paddington to Plymouth, England—a distance of 245.75 miles in 234 minutes—without a stop. The train consisted of five cars, weighing 125 tons; the weight of the locomotive is 54 tons and that of the tender is about 35 tons. The average speed for the entire distance is 63 miles per hour.

A ten-car Manhattan Beach train was recently run on the elevated lines, Brooklyn, New York, to take the New York Twenty-third Regiment on an excursion. This was the longest train that has been run on an elevated road. It was made up of ten motor cars. Each car had four 60-horsepower motors—forty motors in all. These forty motors were all connected on the circuit, giving the train a propelling power equal to 2,400 horse power.

The hulls and machinery for the five battleships for which Congress made an appropriation for the fiscal year, commencing July 1, 1903, will cost, when completed, about $20,000,000, and the armor, armament and equipment will require an additional outlay of $1,500,000. The annual depreciation of these vessels, taking into consideration their wear and tear as well as their fighting value, is estimated to be at least 4 per cent., or a total of nearly a million and a half dollars; and this is exclusive of the running expenses of these expensive attributes of the "majestic arm of the law."

In the paper "Axle Lighting" read before a recent meeting of the American Institute of Electrical Engineers by Mr. Elmer E. Sperry the statement was made that in August, 1882, the Pennsylvania R. R. electrically equipped car No. 397 with Faure accumulators imported for the purpose from France. Not only is this the earliest application of electricity to car lighting in this country, but in the world. The first installation of solid electrically illuminated trains, is that of the Pennsylvania Limited, between New York and Chicago, in the middle eighties. These are still in continuous service and all are direct-connected sets in the baggage compartment, supplying the lamps and the storage batteries beneath each car.

The United States Consul at Frankfort, Germany, says that the German papers report the discovery by Mr. Edward Mollard, a Frenchman, of a new metal called "selium." The discoverer, it is said, claims that selium costs but one-twelfth as much as aluminum and is lighter and stronger. It does not rust, and is therefore suitable for use in shipbuilding, for the manufacture of pipes, and for railroad construction. On account of its cheapness—and as it is capable of a fine polish, resembling nickel—it would be desirable for manufacturing cooking utensils. Its density is 2.6, and its hardness not quite that of iron, but greater than lead or zinc. Its power of resistance is said to be greater than that of iron, but less than that of steel. The melting point is high, being about 2900 degrees Fahr. In melting, it contracts somewhat, but molding in forms is not impossible.

The *Scientific American* illustrates and describes what is said to be the largest transformer in the world. It was built by the Stanley Electric Manufacturing Co. for the Pittsburg Reduction Co. to be used in their Niagara Falls plant for the manufacture of aluminum. The transformer is of 2,000 kilowatt capacity. The primary circuit receives current from the Niagara Falls of 908 amperes at 2,200 volts. This current is "stepped down" in the secondary winding to 40,000 amperes at 50 volts, the manufacture of aluminum requiring a powerful current of low voltage. The transformer measures 7 feet, 2 inches square at the base and is 8 feet, 8 inches high. The coils are oil cooled, being incased in a tank which is filled with heavy mineral oil. The heat absorbed by the oil is in turn absorbed by a coil of pipe in the top through which is circulated cold water.

Petroleum was first used for road purposes in California in 1898, solely for the purpose of laying the dust, which, during the long dry seasons, become a serious nuisance if not a menace to life and property. It was soon discovered, however, that not only does the petroleum serve the purpose of making dustless roads, but it immediately begins to bind together the loose particles constituting the road surface, whether clay, sandy loam, loose sand, gravel or fine material on top of macadamized roads. A tough stratum is formed, resembling asphalt pavement. Roads built on drifting sand or clayey dust, no matter how deep, where trotting with a buggy was impossible and for a pair of strong horses to pull a ton was a very laborious process, became indurated, resilient, and firm, so that driving teams could trot with ease and the same pair of horses pull 2½ tons more comfortably than they formerly did one ton. Petroleum having a large percentage of asphalt in suspension as have the heavy oils of California and Texas, is best for road-making purposes—and cheapest.

The proposed race of airships at the St. Louis Exposition has done much to stimulate the invention and production of motors of extremely light weight, and, according to the *Scientific American*, a gasoline motor has been constructed by the Walters Power Company, Jersey City, which is the lightest on record for an engine of this type. The contract stipulated that the motor alone should weigh not more than 26 pounds and should yield at least 2 horse power. The completed motor comes well within these requirements, having a weight of about 24¼ pounds and an output of 2¼ horse power. Even with the addition of the carbureter, the weight is but 25½ pounds. In the construction of the motor aluminum is used wherever possible, and the other parts are made as small and compact as practicable. The general design, however, closely follows standard lines. The motor is of the four-cycle type and the cylinders have a 2⅛-inch bore by a 2 7-16-inch stroke. One feature which is particularly noticeable is the absence of radiating ribs on the main body of the cylinders. It was found that the heat of the cylinders could be dissipated with sufficient rapidity from the smooth surface of the cylinder. However, in order to insure sufficient strength the ribbed formation is retained on the cylinder heads and the valve casings, for at these points the pressure is the greatest.

Much interest is evinced in engineering circles by the approval of the Naval Board of Construction of Rear Admiral Melville's report recommending that one of the new scout ships to be constructed for the government should be equipped with steam turbines. The construction abroad of the two English Channel turbine steamers the past year, and their successful performance, and this action on the part of the Navy Department in this country, will both have a powerful influence tending to the introduction of turbines on ocean-going steamships of much larger size. In his report, submitted previous to his retirement from the active duties as Engineer-in-Chief of the U. S. Navy, Rear-Admiral Melville said:

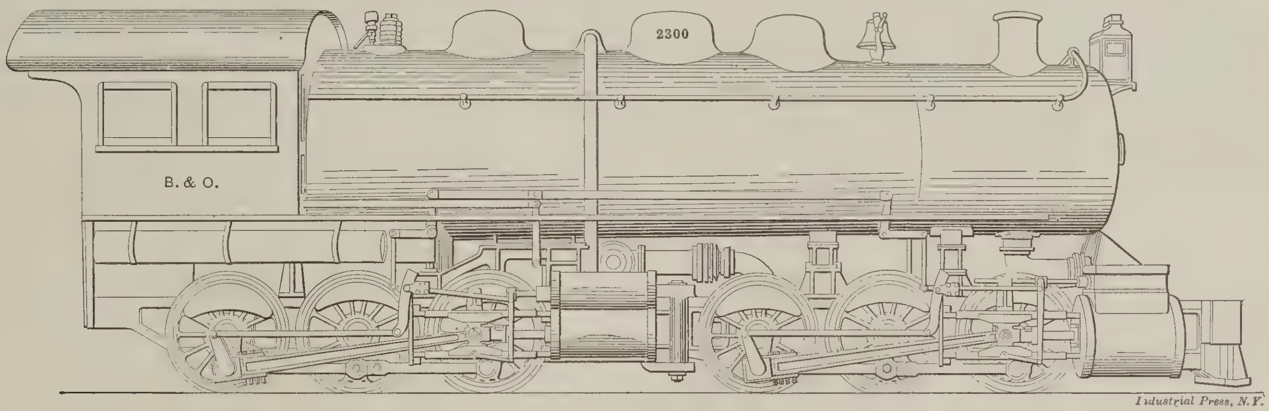
"I respectfully recommend that one of the new vessels of the navy of not more than 5,000 tons displacement, and preferably of the scout or very fast cruiser class, be fitted with steam turbines instead of reciprocating engines. My reasons for this recommendation are that the steam turbine has now passed beyond the experimental stage, and various vessels in which it has been fitted, particularly fast passenger steamers, have proved eminently successful." He adds that the ability to use highly superheated steam, the few moving parts and the reduced engine room are in themselves sufficient reasons for extensive experiments with the steam turbine; and he favors the installation of such turbines in a small vessel, not because they may not prove efficient on a larger one, but because he believes that it is not a good policy to change the motive machinery in the larger ships until it has been shown by exhaustive trials on the smaller scout ships that it will be wise to make the change.

MALLET ARTICULATED TYPE LOCOMOTIVE FOR THE B. & O.

Railroad Gazette, September 4, 1903, p. 636.

An order has been placed with the American Locomotive Company by the Baltimore & Ohio R. R. for a very heavy freight locomotive of the Mallet articulated type that has been quite largely built for European railways. It is the intention to have this locomotive perform the work of two ordinary locomotives and to thus dispense with the aid of a pusher on heavy grades.

The Mallet compound is of the four-cylinder type. Usually all of its wheels are drivers, which are arranged in two groups. The rear group is carried by the main frame and is driven by the high-pressure cylinders. The forward group is carried by a supplemental frame and is driven by the low-pressure cylinders. The frame and wheels of the low-pressure engine form a truck on which the forward part of the locomotive is supported. The arrangement gives a locomotive a long total wheel-base but short rigid wheel-base. The total weight is available for adhesion. It is especially adapted to slow, heavy work on grades where sharp curves must be passed. The Walschaert valve gear is used.



Heavy Freight Locomotive for B. & O. R. R.

The building of this locomotive by the B. & O. is an experiment. Should it demonstrate its usefulness in the service for which it is designed, others will doubtless be built. The boiler will carry the unusual pressure of 235 pounds. The following dimensions, furnished by the B. & O., compare the Mallet type with the 1-7 class, which are the heaviest locomotives used on the road in regular freight service.

General Dimensions.	Articulated.	1-7
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Fuel	Bituminous coal.	Bituminous coal.
Weight in working order	285,000 lbs.	193,500 lbs.
Weight on drivers	285,000 lbs.	173,000 lbs.
Weight engine and tender in working order	415,000 lbs.	325,000 lbs.
Wheel base, driving	30 ft. 6 in.	16 ft. 6½ in.
Wheel base, rigid	10 ft. 0 in.	16 ft. 6½ in.
Wheel base, total	30 ft. 6 in.	24 ft. 9 in.
Wheel base, total, engine and tender	61 ft. 5 in.	57 ft. 7½ in.
Width of frame	5 in.	4 in.
Center to center		44 in.
Cylinders.		
Diameter of low-pressure cylinder	32 in.	
Diameter of high-pressure cylinder	20 in.	22 in.
Stroke of piston	32 in.	28 in.
Valves.		
Kind of valves	Balanced.	Balanced.
Type of gear	Walschaert.	Link.
Wheels.		
Number of driving wheels	12	8
Diameter of driving wheels outside of tires	56 in.	56 in.
Material of driving wheel centers	Cast steel.	Cast steel.
Thickness of tire	3 in.	3 in.
Driving box material	Cast steel.	Cast steel.
Diameter and length of driving journals	9 in. x 13 in.	9 in. x 13 in.
Boiler.		
Style	Wagon top.	Belpaire wide fire-box.
Working pressure	235 lbs.	205 lbs.
Inside diameter of first ring	76 in.	69½ in.
Horizontal seams	Sextuple riveted. Butt seam.	Double welt. Butt seam.
Circumferential seams	Double riveted.	Double riveted.
Fire-box length	105 in.	104⅞ in.
Fire-box width	77 in.	66 in.
Fire-box water space, front	5 in.	5 in. bot. 7 in. top.
Fire-box water space, sides	5 in.	5 in. bot. 6½ in. top.
Fire-box water space, back	5 in.	4 in. bot. 7 in. top.
Fire-box crown staying	Radial.	
Fire-box staybolts	Flexible and screw	Flexible.
Tubes, number	376	369
Tubes, diameter	2¼ in.	2 in.
Tubes, length over tube sheets	18 ft. 9 in.	13 ft. 9½ in.
Tubes, heating surface	4,135	2,662.92
Fire-box, heating surface	190	184.32
Total heating surface	4,325	2,847.24
Grate surface	56.1	48.06
Height of stack above rail	15 ft.	15 ft.
Ratios.		
Heating surface to grate surface	77.1	59.24
Heating surface to cylinder volume	.0068	.00216
Tractive power	63,800	39,688
Heating surface to tractive power	15.43	13.98
Tractive power to weight on drivers	4.46	4.31
Tender.		
Tender frame	Channel.	Steel.
Water capacity	7,000 gals.	7,000 gals.
Coal capacity	13 tons.	13 tons.

FRICTION BETWEEN WOOD AND IRON.

Engineering (London) August 21, 1903, p. 254. (Translation.)

The civil authorities in the Dortmund colliery district finding there was no accepted standard friction coefficients of wood on iron for the guidance of those having to design brakes for the winding drums used in mines, requested Professor L. Klein, of Hanover, to investigate the subject. In his experiments the test pulleys, which were mostly 15.75 inches diameter, were driven by a Pelton water wheel working under a constant head of 85 feet. The brake blocks were attached to a lever from the end of which weights were suspended. The machine having been gaged with the aid of straps, cords, and steel bands and spring balances, and very good curves having been obtained, experiments were made in three different ways. In the first set the load and speed were varied, but the pressure kept constant by altering the surface in contact, in accordance with the load. In the second set the pressure was increased, while the speed was kept constant. In the third set the speed and pressure were varied, the braking area being kept constant. This third method was finally applied because the experiments established that, within certain limits, the speed and pressure did not affect the friction coefficient. The limits were circumferential speeds from 3¼ feet to 65 feet, and pressure from 7 pounds to 142 pounds per square inch. Constant figures were generally arrived at after about half a minute.

As a rule the wood fiber was parallel to the pulley face, as in ordinary practice (*a*); sometimes the fiber was placed crossways to the pulley face (*b*); and end grain blocks were also tried (*c*); the letters indicate these conditions in the tables in which we summarize the results. Table I. concerns pulleys of cast iron or wrought iron finished smooth; *A* means that the pulley was carefully wiped, *B* that it was cleaned with benzine; *C* that the wood was soaked in oil. Table II. concerns wrought-iron pulleys not specially finished. In this case, as is well known, the rough points on the surface cause the brake-block to oscillate; the braking effect is hence diminished and more uncertain, as the pulley has time to slip away under the block when it is not pressed on. Definite values, therefore, cannot be given. Beech and oak suffer more on rough pulleys than poplar, elm and willow, but are more efficient in braking power, probably because the charred particles fill up the rough spots. Poplar proved to be the best brake-block material; it gives high friction and is little affected by oil. Willow is inferior, being sensitive to oil and giving diminished friction under heavy loads. Carefully finished and cleaned wrought iron is a better friction pulley material than rough wrought iron or cast iron.

TABLE I. SMOOTH PULLEY FACES.

Material.	Beech	Oak.			Poplar.			Elm.	Willow.
	a.	a.	b.	c.	a.	b.	c.	a.	a.
Cast iron—A	0.28	0.29	0.25	0.19	0.34	0.30	0.29	0.32	0.43
	0.29	0.30	0.28	0.20	0.35	0.36	0.31	0.36	0.46
	0.30	0.31	0.35	0.21	0.37	0.40	0.37	0.38	0.48
B	0.36	0.30	0.35	..	0.39	..	..	0.36	0.41
	0.37	0.31	0.37	..	0.40	..	..	0.37	0.47
	0.38	0.32	0.40	..	0.41	..	..	0.39	0.50
Wrought iron —A	0.51	0.48	..	..	0.52	..	..	0.57	0.41
	0.54	0.51	..	..	0.65	..	..	0.60	0.63
	0.55	0.54	..	..	0.73	..	..	0.64	0.93
B	0.52	0.38	..	..	0.56	..	..	0.47	0.58
	0.54	0.40	..	..	0.60	..	..	0.49	0.60
	0 55	0.42	..	..	0.62	..	..	0.51	0.62
C	0.28	0.41	..	..	0.49	..	..	0.34	0.33
	0.35	0.50	..	..	0.63	..	..	0.40	0.38
	0.41	0.59	..	..	0.74	..	..	0.42	0.45

TABLE II. ROUGH WROUGHT-IRON PULLEY—FIBER ALWAYS PARALLEL TO PULLEY FACE (a).

Material.	Beech.	Oak.	Poplar.	Elm.	Willow.
Pulley wiped	0.24	0.38	0.15	0.09	0.13
	0.39	0.47	0.18	0.14	0.14
	0.49	0.56	0.25	0.17	0.15
Pulley slightly oiled	0.16	0.12	0.17	0.14	0.15
	0.23	0.15	0.23	0.21	0.17
	0.34	0.28	0.35	0 29	0.21
Brake block soaked in oil	0.10	0.12	0.11	0.11	0.13
	0.12	0.13	0.11	0.12	0.15
	0.14	0.15	0.12	0.14	0.16

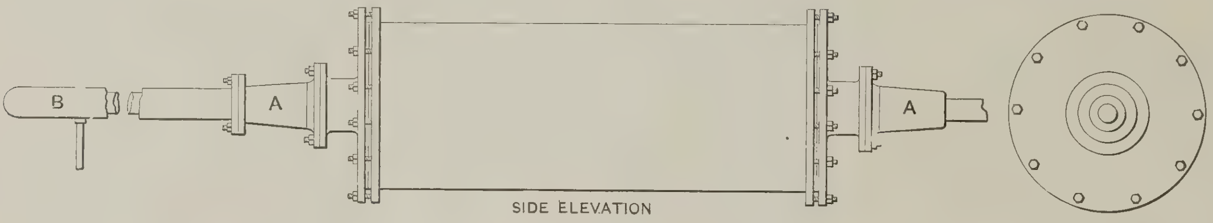
ENGINES AND PUMPS WITHOUT GLANDS.

Mechanical Engineer, England, August 29, 1903.

An interesting paper, read by Mr. Andrew Watson before the Mining Institute of Scotland on mine engines and pumps having no glands or soft packing for the piston rods, was published in the *Mechanical Engineer* of August 29, 1903. The principle employed is that of parallel grooves in the rod, or in the internal surface of a "horn," which takes the place of the ordinary gland. These grooves fill with condensation, making what is ordinarily known as "water-packing." The principle is one that has been used in this country to considerable extent in the construction of pressure regulators and similar apparatus that must work with a minimum of friction, but so far as we know it has never been used for the packing of steam engine piston rods, except in the case of tandem compound engines, between the high and low-pressure cylinders.

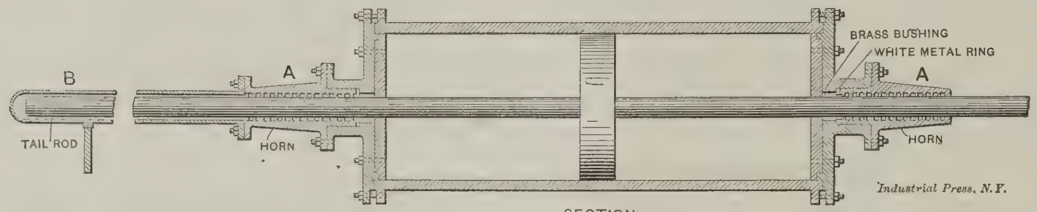
It appears from the paper referred to that mining engines have been in successful use in some of the Scottish collieries for 40 years, which have no glands, but instead have "horns," as shown at *A* in the figure. These horns are bored to fit the piston rods and are internally grooved, the grooves being parallel and about ¼ inch wide and deep. The grooves are cut at a distance of 1 inch apart the whole length of the horn and at the inner end a ring of white metal, bored out to fit the piston and "saw cut" is fitted. This ring has a thickness of about ⅜ inch and a breadth of 1⅛ inch. The first engine fitted in this way had the horn cast upon the cylinder cover, and bored out, as before described. As a precaution a stuffing box was placed upon the end of the horn of the first engine so made, but no packing was used. This engine was in use for a period of 15 years, after which it was sold, and all trace of it has been lost.

The three coupled winding engines at Cadzow Colliery, with cylinders 24 inches diam. and 5 feet stroke, working at a pressure of 80 pounds per square inch, have been altered by simply fitting the horn upon the stuffing boxes, as before described. The horns might be made longer than they are at present, but they work most satisfactorily, and allow no steam to pass out. An iron casing, *B*, with an inside diameter ⅝ inch greater than that of piston rod, is fixed to the outer flange of the horn, enclosing the piston rod, and into the space between the casing and the rod a small quantity of exhaust steam is allowed to pass. This maintains the piston rod at a temperature of about 212 deg. F. If large slow pumping engines were so fitted it is certain that a considerable saving in steam would ensue, as the loss caused by using cold piston rods must be great.



SIDE ELEVATION

END VIEW



SECTION

Piston Rod with Packing without Glands.

At Cadzow Colliery, working under full load, it has been found that since the horns have been fitted to the winding engines, full steam is admitted for 8½ revolutions per minute, whereas, when ordinary packing was in use, steam was admitted for 9½ revolutions. It should, however, be noted that before the horns were fitted the piston rods were not in good condition. Experiments made with one of the pistons of these winding engines showed that when disconnected from the cross-head and in a position ready for work, the piston and rod, weighing fully 1,000 pounds, could be easily pulled by one man along the cylinder. A Salter spring balance was fixed to the outer end of the piston rod and registered 100 pounds—the power necessary to start and move the piston and piston rod. If a marking of white lead be put on the rod it remains on it for hours. These horns have been in use at Cadzow Colliery for six years, and the repair and upkeep of the same are practically nil.

The advantages of having engines fitted with these castings or horns are as follows: 1. There is a minimum of friction and consequent saving in the consumption of steam. 2. The piston rods last very much longer, owing to the diminished friction and wear. 3. The rods carry the piston, so that the piston may be said to float, and does not rest on the bottom of the cylinder. 4. There is a saving in packing and labor, and it is no longer necessary to stop the engine at possibly inconvenient times in order to pack the stuffing boxes.

PICKLING CASTINGS.

Railroad Herald, August, 1903, p. 13.

There are two general methods of treating castings, which are to be machined, to remove hard scale, viz.: the sand-blast and the acid bath. Iron castings are usually pickled with sulphuric acid or hydrofluoric acid, the former being most commonly used. The sulphuric acid pickling solution is usually made up of one part of sulphuric acid to ten parts of water. The sulphuric acid should always be poured into the water while the latter is being stirred. The reason for this is that a chemical reaction takes place which causes the bath to become quite warm, but there is no dangerous ebullition if properly mixed. But if the water is poured upon the sulphuric acid, the latter, being much heavier than water, remains at the bottom. When an attempt is made to stir the solution, the water enters the acid in small streams, and is instantly raised to the boiling point, generating steam, which may cause an explosion. Such an accident would be likely to throw the concentrated acid over the workman and result in serious burns.

Sulphuric acid will not attack the sand or black oxide of iron which form the scale upon castings, but the sand and scale are porous and the acid soaks through and attacks the iron under the scale. It finally dissolves a sufficient amount of iron under the scale to loosen the latter. When the workman sees that the scale is all loose the castings should be removed and washed, preferably with hot water. If the castings are small it is a good practice, after washing, to immerse them in a soda solution for a short time in order to thoroughly neutralize any acid.

One great objection to the use of sulphuric acid as a pickling solution is that if there are any soft or spongy spots in the iron, the acid will penetrate these, and it would be practically impossible to wash it out or neutralize it in the soda bath. Any acid thus entrapped in the castings will continue to eat until it is changed to sulphate of iron or green vitriol. This will tend to make the spongy or soft spots in the iron still worse and may weaken the castings to a large extent. If the acid has been used a number of times a large portion of it is converted into green vitriol, and hence the solution will not attack the iron. In this case it is necessary to add more acid to the bath or else to throw away the old bath and make up a new one.

While the workmen may receive quite serious burns from sulphuric acid it is not nearly as dangerous as hydrofluoric acid. The thin hydrofluoric acid will penetrate the skin and attack the flesh and bones underneath and may result in very serious injuries. It will also attack the finger nails very readily, but if used with care it makes a pickling solution which has a number of advantages over sulphuric acid.

Hydrofluoric acid is commonly sold in three grades. The first contains 30 per cent. of acid, the second 48 per cent., and the third 52 per cent., the balance of the solution being water. The 30 per cent. solution is that usually employed for pickling castings. One gallon of the 30 per cent. solution should be used to twenty to twenty-five gallons of water. If it is desired to pickle more rapidly less water may be used, and if it is desired to get more use of the acid—that is, make it do more work—slightly more water may be used. Hydrofluoric acid does not act upon the iron to an appreciable extent, but attacks the sand and dissolves it. It also dissolves the black oxide of iron.

When castings are pickled in sulphuric acid the surface is left with a dull or black appearance. When pickled in hydrofluoric acid the surface has a much whiter and often almost silvery appearance. The surface of castings pickled with hydrofluoric acid is also very much smoother than those pickled with sulphuric acid. For this reason hydrofluoric acid pickling is used in almost all cases in which the parts are to be polished or nickel-plated, and sulphuric acid pickling only in cases where it is desired to remove the scale so as to facilitate the machining of the castings.

When pickling with hydrofluoric acid the small casting may be put into the bath and the larger ones may have the acid poured over them just as if working with sulphuric acid. The hydrofluoric acid bath is always used cold, but should be kept above the freezing point. The bath can be used repeatedly by adding about one-third the original quantity of acid before introducing a new lot of castings. If it is desired to keep the surface of the castings bright after they are pickled in hydrofluoric acid they should be washed with hot water immediately after coming out of the acid and should be left in the water until they are heated through. If this is done when the castings are taken out of the water they will dry quickly from the heat which they have absorbed from the water. If the castings are washed in cold water they will remain wet for some time and hence will rust. A little lime is frequently added to the washing water which is used after hydrofluoric acid pickling.

When handling concentrated hydrofluoric acid the workman should always use rubber gloves. If any acid is dropped or splashed on the skin it should be washed off at once with water and dilute ammonia and this will usually prevent any injury. The dilute hydrofluoric acid of the pickle bath will not attack the skin instantly, but the workman should never put his hands into this solution, as it will attack the hands to some extent and will result in serious sores if he persists in handling the castings when wet with the pickling solution. The dilute sulphuric acid pickling solution will not injure the hands if it is spilled upon them; in fact, its only effect is to make the skin coarse and rough.

For pickling brass castings a solution is frequently made up by mixing three parts of sulphuric acid and two parts of nitric acid and adding to each quart of the mixture about a handful of common table salt. This mixture is frequently used undiluted with water and is to be handled with great care, as it will attack the hands badly. One advantage of this solution is that it leaves a good color on the castings, and hence it is frequently used for this purpose.

The pickling solution used for brass castings must be kept in an earthenware crock or in a vitrified bath tub, and the bath must be large enough to dip the large castings into it. Owing to the fact that hydrofluoric acid will attack sand it cannot be kept in a crock or jug, as it would immediately eat a hole through it and escape. Hydrofluoric acid must be kept in a lead carboy, but the dilute acid can be kept in wooden tubs or barrels. Either dilute or concentrated hydrofluoric acid will dissolve glass very readily, and hence cannot be kept in a glass bottle. Concentrated sulphuric acid is frequently kept in iron tanks, but dilute sulphuric acid attacks iron readily, and hence it is necessary to keep dilute sulphuric acid in earthenware jugs and jars, glass bottles or wooden tubs or vats.

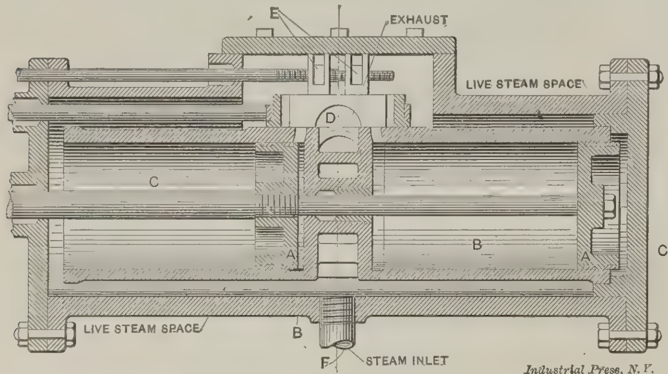
NOVEL JACKETED ENGINE.

Power, September, 1903, p. 486.

The steam engine, a longitudinal section of the cylinder of which is shown on next page, was designed by Mr. J. C. Lemon for Mr. Louis Hicks, Cincinnati, O., to reduce cylinder condensation. There are two working cylinders, with a piston in each fixed to a common piston rod, and the two working cylinders are enclosed in an outside cylinder so as to form a steam space entirely around the inside cylinders, thus completely jacketing the cylinder heads, walls and pistons. In addition to this jacketing, the live steam following the pistons in the open ends of the cylinders washes the cylinder walls, and the effect of the whole arrangement is, to a great extent, to supply heat to the admission surfaces.

The valve is a slide valve with cut-off blocks on top, so as to obtain a wide range of cut-off. A trap was attached to the outside cylinder, into which the water condensed in the outside cylinder and open ends of the inside cylinder was drained. It will be observed that each working cylinder is single acting, the combined effect of the two giving the cycle of the common engine. Dimensions follow.

Diameter of cylinder, inches	6.125
Diameter of piston rod, inches	1.0
Stroke of piston, inches	10.0
Displacement of each piston, cubic inches	286.8
Horse-power for one revolution and one pound mean effective pressure	.000724
Clearance in head end, per cent	4.8
Clearance in crank end, per cent	4.2



Industrial Press, N. Y.

Steam Jacketed Engine Cylinder of Novel Design.

The tests show the following interesting results:

First—The lowest steam consumption of record, so far as the designer knows, for so small an engine.

Second—That the steam consumption is lowest when the expansion is the greatest, while in the ordinary engine the best result is obtained at about four or five expansions.

Third—That steam of high pressure (130 pounds gage) is expanded in this engine to atmosphere at exhaust with the minimum loss, thus accomplishing the same result in a simple engine that is obtained by multiple-cylinder engines.

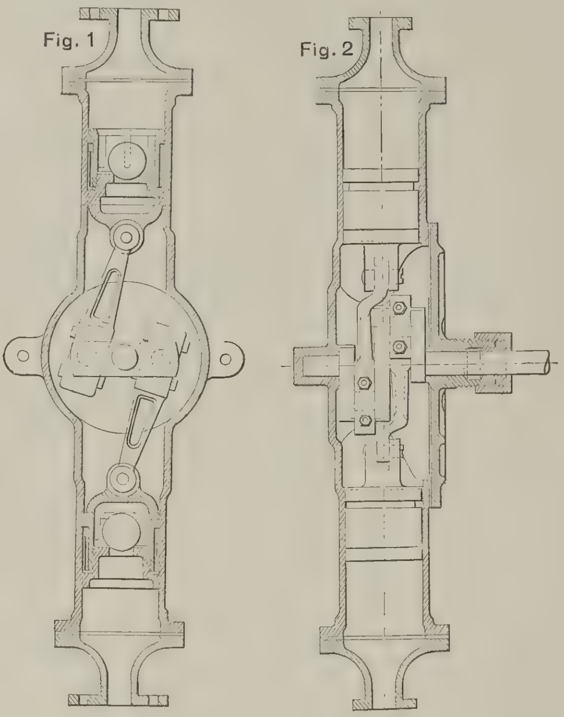
DATA OBTAINED BY TESTS.

1. Number of test	1	2	3	4
2. Cut-off, per cent. of stroke	5.5	9.9	23.4	34.
3. Steam pressure pounds by gage	131.	131.4	132.	133.
4. Average revolutions per minute	89.4	90.8	92.6	90.4
5. Duration of test, minutes	60.	60.	60.	60.
6. Condensed steam from cylinders	59.36	98.25	224.	297.8
7. Total heat in one pound of dry steam at average pressure of test	1190.5	1190.6	1190.7	1190.9
8. Heat in one pound of water at temperature of exhaust	180.	180.	180.	180.
9. B. T. U. absorbed by engine for each pound of steam delivered from cylinder	1010.5	1010.6	1010.7	1010.9
10. Condensed steam from trap	12.25	18.43	18.30	12.20
11. Total heat in one pound of steam used in trap	1190.5	1190.6	1190.7	1190.9
12. Heat in one pound of water at temperature of trap	327.5	327.6	328.0	328.5
13. B. T. U. absorbed by engine for each pound of steam condensed in trap	863.	863.	862.7	862.4
14. Weight of condensed steam from trap reduced to the same basis as that delivered from cylinder Item 13 ÷ Item 9 × Item 10	10.46	15.74	15.62	10.30
15. Total equivalent weight of steam delivered from cylinders	69.82	113.90	239.62	308.1
16. Average M. E. P.	22.48	35.80	60.65	77.73
17. Horse power of engine	2.91	4.71	8.13	10.17
18. B. T. U. per horse power per minute	403.	407.	408.	510.
19. Pounds of steam per I. H. P. per hour	23.99	24.20	29.57	30.30

DOUBLE-ACTING PUMP.

Le Genie Civil.

An interesting double-acting pump was recently exhibited at the Cardiff Exposition of the Royal Agricultural Society by Messrs. W. H. Wilcox & Co., of London. It is here shown in section in Figs. 1 and 2, from which it will be seen that the construction is very simple. It has two pistons which are made to move in opposite directions. Each piston is attached to a crank and carries a spherical valve. When the pistons are moving away from each other a partial vacuum is produced between them and the liquid rises into the body of the pump. On the return stroke the space between the pistons is contracted and a portion of the liquid is forced through the upper valve into the delivery pipe. There is no foot valve, that in the lower piston taking its place. These spherical valves are of rubber and the pistons are packed with leather. In the operation it is a matter of no moment whether the shaft makes a complete revolution or not and it can be moved by power or by hand.



Industrial Press, N. Y.

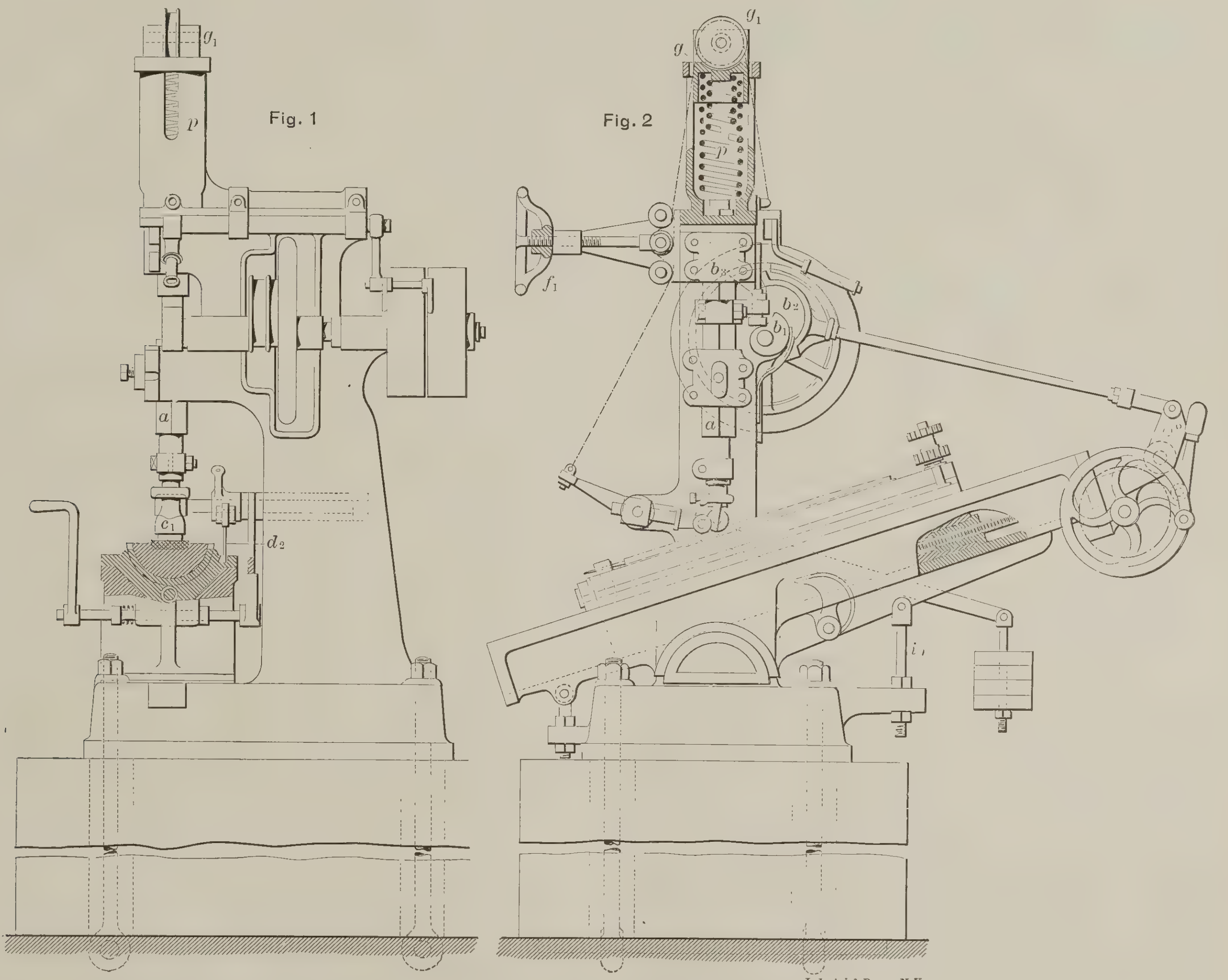
Pump without Cylinder Heads.

G. L. F.

CARBORUNDUM AS A FURNACE LINING.

Electrical Review, August 28, 1903, p. 351.

Further details as to the employment and value of carborundum as a furnace lining, and as a means of preserving less refractory materials against fire or high temperatures, to which brief reference was made in the issue of December 12, 1902 (see MACHINERY for February, 1903), have been given in a recent article printed in the German *Zeitschrift fur Beleuchtungswesen.* When any object such as a crucible, retort, or furnace is to be treated, the carborundum powder is mixed with one-third its weight of water-glass, and the whole diluted with water until it forms a cream suitable for application with a stiff brush. If, however, the carborundum is likely to come into contact with basic substances, either basic bricks or basic slags, the water-glass is replaced by fireclay, using 85 parts of carborundum to 15 of the clay. It is then laid on the surface which is to be protected just as if it were an oil paint, and in such quantity that it forms a layer about 1-50-inch thick. To produce a film of the thickness quoted requires about 3½ ounces of carborundum per square yard. Brickwork must be thoroughly air-dried before the coating is put on; mortar especially must be as dry as possible, or, on heating, evolution of steam may blow the coating off. Massive structures of brickwork are best heated gently for some time and then permitted to become cool before the "paint" is applied. When the painted surface has been allowed to dry for 24 hours, it is ready for use; but it should be warmed slowly the first time. Gradually the water-glass disappears, and the carborundum remains as a kind of glaze, which is perfectly smooth, does not form a slag with the ash of any fuel, withstands rapid heating and cooling, and does not chip off. The process is available for any furnace or apparatus used in connection with gas or solid fuel firing. At the Düsseldorf Exhibition, a tube-welding furnace was shown, which had been given a 1-50-inch coating of carborundum and water-glass. This furnace was worked for 10 hours a day for 6 months, and at the end of that period was in as good condition as at first, no repairs having been called for. A mixture of equal parts of carborundum and fireclay can also be employed to stop any cracks in coal gas retorts, being capable of application while the retorts are still hot. In one experiment two leaky retorts were mended in 3 minutes, and they afterwards lasted for 3 months. If the retorts are to be repaired cold, the usual mixture of carborundum with water-glass should be used, but in other cases that with fireclay is preferable. Porcelain crucibles are, with advantage, coated inside and out with the same protective layer; this makes them last longer than usual, and enables them to bear rapid and frequent changes of temperature. Crucibles for the manufacture of steel are better painted on the outside only.



Industrial Press, N.Y.

Special Machine for Cutting Files.

FILE-CUTTING MACHINE.

Der praktische Maschinen-Konstrukteur, July 16, 1903, p. 120.

The machine consists of a light frame anchored to its foundation by four bolts; a table which can be moved along its support as shown in Figs. 1 and 2 and which may be set at any delivered cutting angle by the adjusting screw *i*. The hammer *a* is carefully fitted and is always held in its closed position. The blow is dealt by means of the back spring *p* the strength of which is regulated according to the size of file being cut; a light spring being used for small and a heavy for large files. The actual strength of the blow delivered can be regulated according to the size of the spring by the handwheel f_1. The pressure chain, which may be tightened by the handwheel, passes up and over the roller g_1, against which the spring cap *g* has a bearing, and thence down to the frame of the machine where it is fastened. The automatic regulation of the blow, which is always proportioned to the file being made, is effected by the crank arm d_2. By means of an arrangement, not shown in the drawings here reproduced, a foot treadle can be used to easily and quickly regulate the blow to any degree of intensity. This is of special importance in the cutting of three-cornered files where the blow must be comparatively light at the point, and heavier at the middle and tang. In order to obtain a fine tooth at the point, there is an arrangement whereby the pressure is automatically relaxed as the chisel approaches the point of the file. The operating mechanism is shown in Figs. 1 and 2, in which the checknut b_3 is loosened and the chisel c_1 is brought down against the thinnest part of the file to be cut. Then this checknut is run down towards the tappet b_1, and so held that there will be a play of from .2 to .6 inch according to the type and size of file to be cut.

Power is applied through a tight and loose pulley shown at the side of Fig. 1, and operates upon the lift of the hammer through the cam shown at the side of the same illustration. The feed of the table with the file is effected by means of an eccentric b_2 with a ratchet connection to the mechanism shown at the right of Fig. 2. G. L. F.

ERICSSON, THE MAN.

Egbert P. Watson, in the Iron Age, August 13, p. 12.

The dedication of a new statue to the memory of John Ericsson at Battery Park, New York City, the first of August, led Mr. Egbert P. Watson to contribute some brief reminiscences of the great engineer in a short article in the *Iron Age*. Mr. Watson knew Ericsson for twenty-five years and as a machinist at the old Novelty Iron Works, New York, worked on the *Monitor*, and in fact, drove the first bolt in her turret. Later he held an editorial position on a technical paper and took occasion to comment favorably on the *Monitor*, before it had gone into commission. The vessel had many enemies in high positions so that Ericsson was grateful to anyone who stood up for her. Mr. Watson had not met Ericsson up to that time and consequently was greatly surprised to receive a note, asking him to call. Now this was a very unusual thing; the country was in the throes of civil war, and every one was at the highest tension, Ericsson especially, for his reputation and fortunes were staked upon what might happen within a very few hours. That he should be capable of unbending for an interview with a total stranger, when he refused to see officials of high standing in the army and navy was remarkable, to say the least. The appointment was kept and a very brief one it was, merely rushing in and rushing out of the room upon Captain Ericsson's part, with a cordial grasp of the hand and a few words to express his obligations for the article, and Watson found himself upon the doorstep, being literally thrust out by Ericsson with a "Good morning, sir, I am busy."

Mr. Watson further relates:

Thereafter I had occasion to call, by his invitation, many times, and saw him under all conditions of life, once when an attempt to blackmail him had been made by a fatuous reporter of a daily paper. To say that he was angry is a very mild expression; he was simply furious. The reporter had an article with him written by some one on the staff which he said Captain Ericsson might like to see before it was published; it raked the *Monitor* system fore and aft as a mere job to get the people's money. Ericsson read the article and then asked the reporter what it would cost to suppress it—to trap him. The reply was:

"One thousand dollars."

"Go and publish it, you infernal scoundrel; I do not care what you publish. I live for the truth, but you are an infernal liar; I will not have such a man in my house another moment; get out!"

I saw him just after this incident and he was still fuming from it.

This narrative, to be truthful, should record that this was frequently his mood, and he had much to make him so.

Ericsson was by nature a most forceful man, combative and assertive to a marked degree; he was not diplomatic or reticent about anything; if he had an opinion he gave it in old fashioned Anglo-Saxon terms that left no doubt of what it was. Once when I supposed I had invented a desirable form of screw propeller he looked it over carefully, and then said: "It is not worth a damn." On another occasion, however, when I showed him a working model of a lever engine, a type he particularly approved of, he said it was excellent, very good indeed, and he would like to see it in action. He asked how fast the model had run (it was 4 feet long and 8 inches beam), and when I replied at the rate of three miles an hour for a short distance, he said: "My, my! You have done a great thing; I never could make a model go faster than one and a half miles an hour."

These incidents are not related because I happened to be an actor in them, but for the reason that they show Ericsson to have been fair-minded and not incapable of seeing value in the ideas of others, although this view is taken by many at this day, upon very slight evidence.

It is not generally known that for his *Monitor* plans Ericsson never received one penny from the government in any form, and all bills introduced in Congress to compensate him were killed by his enemies. It was the same with the United States steam vessel *Princeton*, which was the first screw steam vessel of war owned by the navy, and the pioneer in naval screw steamers, although the English naval steam vessel *Ranger* was built shortly after. Through the influence of naval officers of the period Ericsson was never rewarded for her plans and engines, which were a distinct innovation at that time. These things had their influence in a marked degree, and while he was a man who would not submit to an injustice if he could help it, in these instances he was powerless. Another incident which happened long after the civil war came about through the neglect of the managers of the Centennial Exposition, in 1876, to invite Captain Ericsson to contribute a history of his inventions. He was greatly chagrined, but this could be remedied, and he set about it. It took the form of a large volume containing his principal engines and devices of every kind from the beginning of his career. It was profusely illustrated with costly engravings and printed on plate paper made expressly for it. The edges were gilded with pure gold, or 18 carat, at least, and bound in the best turkey morocco. This book cost $60 a volume or $60,000 for an edition of 1,000 copies for complimentary distribution; none of them was ever sold by Ericsson. It was doubtless the most costly work ever gotten out in this country.

Although Ericsson was not a wealthy man he was very lavish in his expenditures and his right hand never knew what his left had given away. At one time he was having a large, intricate casting for a surface condenser made at the Morgan Iron Works, New York. The casting had been poured and the foreman of the foundry wanted to leave it in the sand to cool; but Ericsson was anxious to see it and ordered it dug out. It looked all right and after a little badinage with the foreman about his timidity Ericsson went away. The next day, however, told a different tale—the shrinkage had torn the casting in two and the foreman awaited his visit with anxiety. When he came and saw what happened he merely said: "Can you make another with what you know now?" "Yes, sir," said the foreman. "Go ahead then," said Ericsson. That condenser casting cost $1,500 and the loss fell upon Ericsson.

In appearance Ericsson was of middle height, but he had immense shoulders and chest, and must have possessed great strength; his countenance was stern and forbidding, but when pleased he could lighten up, and in that mood was a handsome man. During the last thirty years of his life he lived in what was once a popular residence section of New York, but had finally become a cheap boarding-house section, inhabited by many Italians and with a "flavor of mild decay" over all. He disliked change so much, however, that he could not be induced to move to other quarters.

The models of all his inventions were displayed in glass cases around the room, and they were beautifully made. Every detail was constructed upon a certain scale and woe be to the model-maker if he departed in the least from the drawing. Ericsson was a fine draftsman and declared that all dimensions were on his drawings and that the machine would go together if the drawings were followed. At 84 years of age he sent his secretary with some drawings to show me that his hand had not yet lost its cunning. They were surprisingly clear for a man of his years. Late in life he shunned all association with every one. He had become very deaf and was sensitive to his infirmity, but he did not forget anyone who had ever had his regard and confidence.

* * *

TRAIN RESISTANCE AT HIGH SPEEDS.

The signification of T_1 was accidentally omitted from the note "Train Resistance at High Speeds," which appeared in the *Engineering Review* section of the September number. Therefore the formula is repeated in the following, with the signification of all the symbols employed:

$$S = \frac{4 + 0.13\,V + 0.004\,A\,V^2\,[1 + 0.1\,(n - 1)]}{T_1}$$

where

S = the train resistance in horse power per ton;

V = the speed in miles per hour;

A = the cross sectional area of the car in square feet;

T_1 = weight of train in tons;

n = the number of cars in the train inclusive of the locomotive.

* * *

According to experiments made in Germany the danger of firemen receiving a fatal shock when playing a hose onto a charged electrical conductor, is not nearly so great as has been popularly believed. First, it has been shown that the resistance of the human body from the hand to the earth when standing on wet ground, is not less than 15,000 ohms, and that a current of 0.03 ampere is not fatal under ordinary circumstances, although dangerous. A stream of water was directed by a nozzle onto a bare wire having a cross-section of 0.145 square inch and carrying a three-phase current of 6,000 volts. With the end of the nozzle only 12 inches from the bare wire, the tests demonstrated that it was not possible to receive a fatal shock when pure water passed through the hose. But with the water containing 0.5 per cent. of soda, the distance must be increased to nearly 40 inches before there is no danger of fatal shock. On a 550-volt direct circuit with the nozzle directed onto the wire at a distance of less than 1¼ inches from it, the actual current transmitted through pure water was only 0.016 ampere, or slightly more than one-half the limiting value.

A READING ROOM FOR EMPLOYES.

L. G. STEBBINS.

One of the greatest, if not the very greatest, influences upon a man's thought and consequently his conduct is in the matter of his intellectual food, that is to say, what he reads. Everybody who can read, does read, and the tremendous influence of what they read upon their minds and characters cannot be estimated. The public press claims to, and certainly does influence public opinion to a great extent. How is this possible? For the reason that the public reads and the public's opinions and conclusions are formed from what they read concerning a given subject. Almost everybody reads the daily papers, and all, with a mind of average activity, form opinions and arrive at conclusions based upon what they have read about a certain subject. In these days when the workingmen are coming more and more to think for themselves, it is of the utmost importance that their line of thought be in the right channels and their meditations along lines which make for the peace and well-being of the community to which they belong. The best way to secure a pretty evenly-balanced mind is to read only what is moderate, fair-minded and correctly stated, without prejudice or jealousy or anything that tends to warp a man's mental vision. It may be true that some men are born with a taste for the vicious, and such men will of course, be the hardest to deal with, but the great majority of men have minds of good caliber, capable of good mental balance, provided they are developed by proper influences and proper food.

Every employer has it in his power to do something in this work of education, and the results in the long run certainly justify the slight expense he may undergo in his effort to help along a good cause. He can provide some good literature for the men in his employ to read, and he can furnish them a good, light room to read it in, and he can encourage them to spend some of their spare time in the reading room connected with the shop. The plan is entirely feasible, and will work out for the good of both men and employer. Let the employer select a good, clean, light room—in the office building if possible—and furnish it with chairs, long tables, book shelves, paper files, etc. Everything should be selected with a view to comfort and durability, and should not be the cheapest that can be bought. Let the men feel as though the place was theirs to be enjoyed, and they will be a rather unusual set of men if they do not proceed to enjoy it. In the selection of the reading matter the employer should use his best judgment and should have a good assortment at all times so that interest in the enterprise will not wane on the part of the men. Let two or three copies of each of the best local papers be provided, and also two or three of the leading papers of the section of the country where the plant is located, taking care to exclude the sensational and flashy "yellow sheets" which are working untold mischief among the workingmen of our country to-day. Good magazines (the best are not too good) should be accessible, both trade publications and other magazines covering the general field of literature. In addition to this there may be some good books, novels, history, and technical works bearing upon the various phases of the work the men are engaged in. Above all things steer clear of political questions and do not select the reading matter with a view of proselyting the men to your convictions as regards the question of which is the best party. Exclude the rabid paper whether it be of your own party or another.

The expense of providing reading matter for a reading room that would be a credit to the shop ought not to be over $2 per week at the outside, and I really do not know how $2 per week could be spent to better advantage. There will be a good many magazines received gratis from publishers which can go into the reading room, and gifts of books will be forthcoming when the public spirited men of the town learn of what is going on in such and such a shop. The room should be open to all employes, of course, and most of them will drop in, perhaps out of curiosity at first, but later they will have formed the habit of depending upon the reading room for information of various kinds, and by reading and comparing the views of daily papers that are acknowledged to be solid and respectable, with the "yellow sheets" which some of them have been accustomed to read, will be led to drop the sensational paper, and take up the other one. This thing has happened, and would happen often if the comparison between the two classes of papers were brought to their attention daily for a while. The reading room should be open during the noon hour so that the men who carry their dinners may profit thereby, and for two or three hours during the evening. There are generally some men in the shop with natures inclined to be studious, and a man of this character can usually be found who will act as librarian and have charge of the reading room under the head of the firm. Such a man will take interest in the scheme, and will do much towards making the enterprise a success.

It is true that almost every town of any size has a free public library and some will say that there is no necessity for a reading room or library, if you choose to call it such, connected with a shop. The fact is that while there are libraries the workingmen are conspicuous by their absence from the reading rooms of the public institutions. They and their families may draw books from the library, but they are not found in the reading room, poring over the latest and best in science, history or fiction. The best thing about the shop reading room is that it fosters the spirit of fraternal feeling that exists between shopmates, and the men can come to the room without feeling ill at ease because they do not look as well as some one else. They can drop in at the room after supper and mingle with friends, reading good newspapers, and some of them perhaps studying to be better workmen. Occasionally a short, practical talk on some of the burning questions of the day may be given—another means of educating men and training their minds to run in the right channel. Men form opinions from hearing other people talk, and next to reading this is undoubtedly the most important factor in a man's education. In every town there will be found public spirited men, of good character, wisdom and moderate in their expressions, who will be glad to address a gathering of men, realizing as they do that the peace, prosperity and well-being of the community depend on the conduct of the workingmen of the place. A well read, educated man is the best man in the world to have for a neighbor, be he a millionaire or a workingman, and every man who employs ought to be glad to have an opportunity to assist in educating his men so that they will be a credit to him and the town where they belong.

From a purely selfish standpoint—that of returns on the money invested—the enterprise will certainly prove its value after a fair trial. Educated men make good workmen, and good workmen turn out good work, and good work gets good customers, etc., and so on. But a man, be he employer or not, should not worship the money god too fervently, else his efforts may come to naught after all. There is certainly something higher in this world to live for than mere money getting, and happy is the man who learns this early in life and shapes his course accordingly.

The scheme I have outlined is not Utopian to a very great extent, and the whole plan is practical and entirely feasible. Many manufacturers have already instituted reading rooms of this kind and we think they are more than satisfied with the results. It is a movement in the right direction, and a step forward in the march of progress. It will be a great help in the solving of the great question of the day—the labor question—as a man who has absorbed all the good things that have been written in regard to the brotherhood of man, and the relation of labor to capital, views of moderate and fair-minded men both employers and employes, is pretty sure to try and deal fairly when a question comes up for settlement between himself and his employer.

* * *

Out of 16 tests of boiler joints, with nickel steel rivets, made by the Bethlehem Steel Co., the plate failed in two and the rivets in six, when in single shear; and when in double shear, the plate failed in six tests and the rivets in two. In single shear the ultimate shearing strength of the rivets was 45,000 pounds, and when in double shear 88,000 pounds. It was deduced that a ¾-inch nickel steel rivet could safely replace a 1 1-16-inch or even a 1⅛-inch steel rivet.

AN INTERESTING ROPE TRANSMISSION PROBLEM.

The situations and requirements of rope drives are such that it is very seldom that any two installations will be alike, and the engineer in designing a new drive is obliged to refer in almost every case to the fundamental principles governing such drives, rather than to the precedent of former experience.

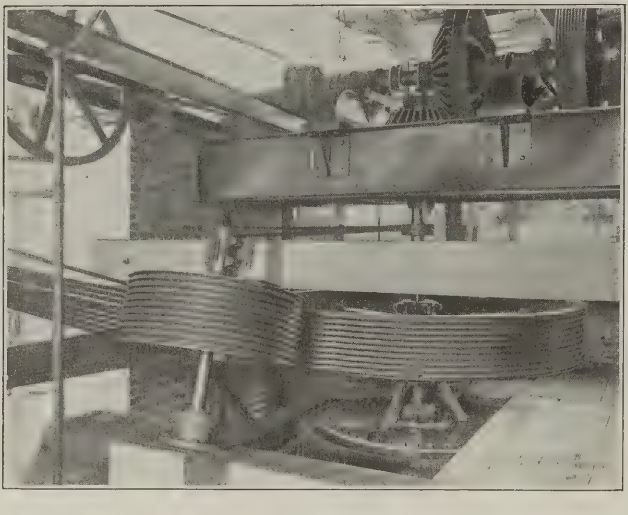


Fig. 1. Showing Wheel Casing and Idler.

An unusual problem was presented in the installation of a rope drive for Messrs. James & E. H. Wilson, operating a large woolen mill at Pittsfield, Mass. The mill was formerly operated by steam power. An excellent water power, however, is located about three-quarters of a mile from the woolen mill, in a building formerly vacant, and which would probably have been abandoned were it not for the water power. Messrs. Wilson purchased the abandoned mill with the idea of using the water power for generating electricity, the electricity to be transmitted for driving their woolen mill, thus taking advantage of the economy of the water power over their steam plant.

The ordinary method of transmitting power from a turbine shaft by means of gears was found impracticable and the only economical method that seemed to be available was by means of manila rope transmission. The shape and dimensions of the wheel house, however, were such that 16 feet was the greatest available distance between the vertical water wheel shaft and the dynamo. The power to be transmitted was 200 horse power, and it is quite evident that these centers were exceedingly short for a rope transmission, especially as on account of the vertical turbine shaft and the horizontal dynamo shaft the drive must be a quarter twist.

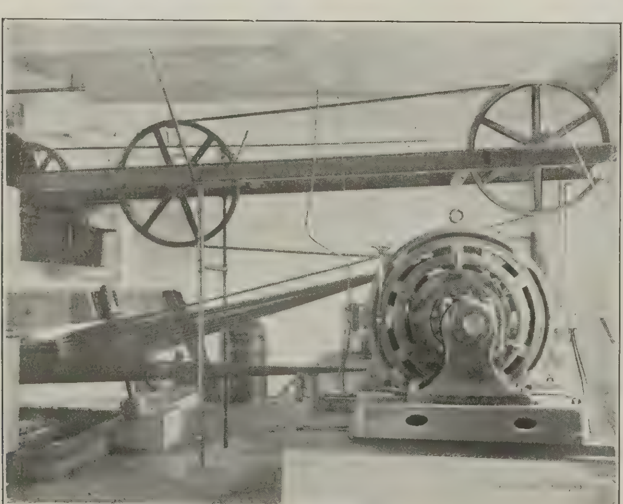


Fig. 2 Generator, with Tension Carriage Overhead.

The plant was designed and installed by H. W. Caldwell & Son Company, of Chicago, Ill., through the engineers in charge of their eastern sales and engineering office at 95 Liberty Street, New York City. So far as the designers are aware, this is the shortest quarter twist drive in use where a considerable amount of horse power is transmitted and a number of ropes are employed.

The illustrations shown will make the arrangement of the drive plain. Fig. 1 shows the water wheel case and the vertical shaft supported at its upper end by a heavy steel construction. The heavy support necessary for the gear drive is some indication of the comparative ease of operation of the modern rope transmission as compared with the old gear drive. In Fig. 1 is also shown the deflecting idler carrying the slack ropes, which, as will be noticed, is placed very close to the driving sheave. A portion of the tension carriage is also shown overhead.

In Fig. 2 can be seen a portion of the driving sheave at the left of the cut. The photograph of Fig. 1 was taken from a position in front of the window shown in Fig. 2. The position of the generator with reference to the driving sheave is clearly shown in Fig. 2; the receiving sheave being on the other side of the generator. The lower ropes are the pulling ropes and the slack is taken to the tension carriage from the driving sheave over the upper groove of the deflecting idler. The one-groove re-winding idler is placed above the generator; from thence the rope passes over the tension carriage sheave and returns to the driven sheave on the generator.

Particular attention is called to the quarter twist arrangement of the ropes, another view of which is shown in Fig. 3.

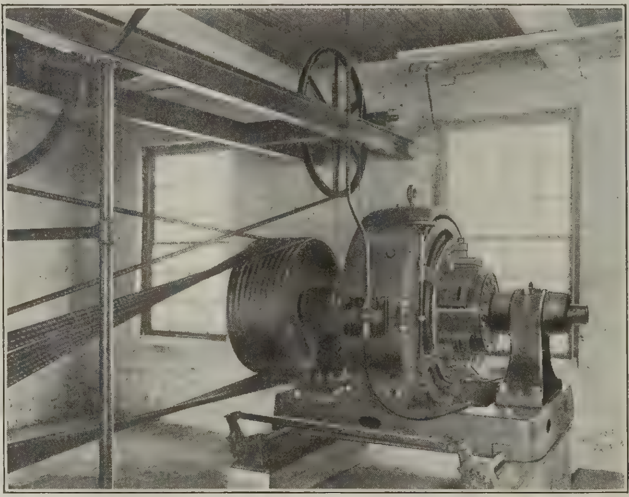


Fig. 3. Generator, showing Receiving Sheave.

In installing the drive the driving and driven sheaves were placed according to the usual rules for setting quarter twist belts or ropes. The 10-groove deflecting idler was placed as nearly theoretically correct as could be, and the tension carriage and the re-winding idler were placed in position. The rope was then wound, and by raising the generator slightly the catenary of the ropes between the driving and driven sheaves was taken into account, so that the ropes would lead correctly between the two sheaves.

The speed of the ropes is about 5,000 feet per minute, and notwithstanding the short centers, high speed, and the many reverse turns, the drive has given excellent satisfaction since its installation. A recent report from Messrs. Wilson is to the effect that the drive is working very satisfactorily—this report coming about a year after the installation of the transmission.

The driving sheave on the water wheel shaft is 96 inches diameter, running 209 revolutions per minute. The driven sheave on the generator is 34 inches diameter, running 585 revolutions per minute. Both sheaves are grooved for ten 1⅛-inch ropes. The distance between the deflecting idler sheaves and the driven sheave is approximately ten feet.

The engineers of H. W. Caldwell & Son Company having this installation in charge feel that the successful solution of the problem is an instructive precedent for the use of rope drives in situations heretofore considered too difficult for this class of power transmission.

LETTERS UPON PRACTICAL SUBJECTS.

MACHINING A DIFFICULT PUNCH AND DIE.

Editor Machinery:

Some years ago the writer was called upon to make a punch and die for producing special washers of the shape shown in Fig. 1. These were to be about 1-32 inch thick, 1⅜ inch in diameter, with a ⅜-inch hole, and to have on the periphery 48 saw like teeth. It will be readily seen that the punch and die for such a piece would not be an easy one to file up. The die was made of a block of tool steel 4 inches long by 3 inches wide and about 1 inch in thickness, and in order to cut the teeth, after it had been bored out, the chuck shown in Fig. 2 was employed.

This consisted of a casting *A*, driven onto the steel shank *B* which fitted the index center of a Hendey shaper. The block was held in the chuck by means of four setscrews, *CC*, while its back rested against the face *E*. This chuck was placed in the index center spindle and the center plate elevated so as to give the proper clearance to the teeth which were cut by the tool shown in Fig. 3. The point of this tool was ground to the shape of the teeth to be cut and the chuck was indexed around, 1-48 of a revolution at each cut, until all of the teeth were properly formed. Through the opening *F*, in the back of the chuck, the operator was enabled to observe the work as it progressed.

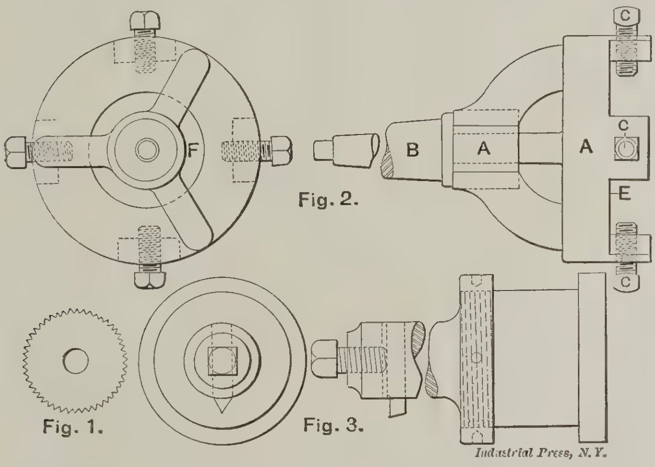


Fig. 1. Fig. 2. Fig. 3.

Chuck and Tool for Making a Difficult Die.

The punch was made upon a universal milling machine using a cutter of the proper angle for the teeth, and indexing the work in the regular index head. After machining as above described, but little filing was required to fit the punch and die so that they produced most satisfactory results. Nix.

A BORING ATTACHMENT FOR THE LATHE.

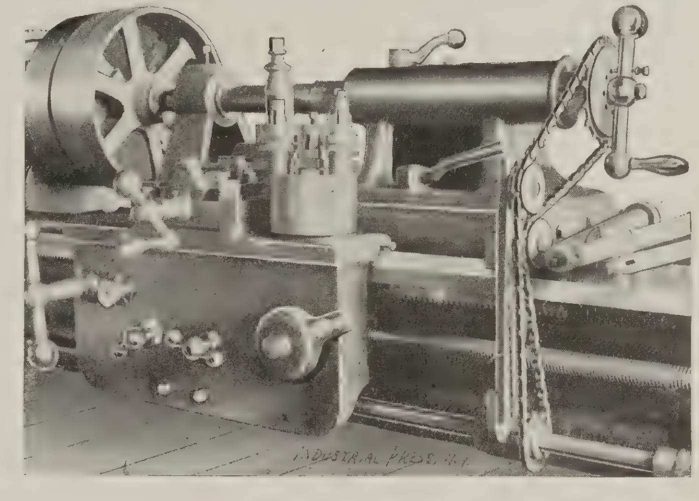
Editor Machinery:

The photograph herewith shows a 16-inch lathe as we have fitted it up for boring purposes. The boring bars fit the tailstock spindle, which has a groove planed across its face in which tongues on the bars engage to prevent their turning, thus relieving the taper shank of this duty. The cutter end of the bar is rigidly supported close to the work by the bracket shown in the cut. Flat cutters are used and are held by a set screw in the end of the bar.

The production and maintenance of these cutters being somewhat expensive led to making some special tools which would facilitate their production. After being cut off in a power hack saw they are placed in a shaper and, several at a time, are planed where they straddle the boring bar. They are then finished in a lathe having stub bars, all fitted to one piece, screwed on the nose of the spindle. They are turned and relieved, and after being hardened, are again put in the stub bar and ground with a grinding attachment which is fitted to the lathe. In this manner they are produced rapidly and accurately and when a set is once made it is rarely necessary to make other than finishing cutters as these are ground down for roughing cutters as soon as they wear below size.

The stub arbors and their holders are shown on the right wing of the carriage, one for each size of bar. Some of the cutters are also to be seen on the cross-slide and three of the boring bars are lying on the lathe bed.

The most important part of the outfit is the arrangement of the power feed for the tailstock. An ordinary bicycle chain is used and as the sprocket on the feed rod as well as the idlers are supported from the tailstock, any movement of the latter does not interfere with the action of the feed. The upper sprocket is a running fit on the tailstock feed screw. It has eight holes in its outer face and in one of these holes the spring pin in the bell crank is slipped to engage the feed.



Lathe Fitted with Boring Attachment.

With a single exception the whole arrangement works very satisfactorily; the lathe is a stiff one and the cutters can be fed through at a high rate of feed. Two or three cutters are used, according to the accuracy required, while holes that need to be better than can be produced with a cutter of this kind are reamed by hand after boring. The one fault mentioned is that the feed should engage and disengage at the feed shaft instead of at the tailstock screw, the advantage being that the chain would then stop with the feed. Corneil Ridderhof.

Grand Rapids, Mich.

TOOLS FOR TURNING AND BORING PISTON RINGS.

Editor Machinery:

While the boring and turning of "snap" rings for small engines does not require any great amount of skill on the part of the operator, since a slight variation is allowed on both inside and outside diameters of the rings, yet if they are to be produced in large quantities, the introduction of special tools which will increase the speed of production will be found a good investment. With this object in view the tools here shown were designed, and judging from the increased output they have served the purpose very well.

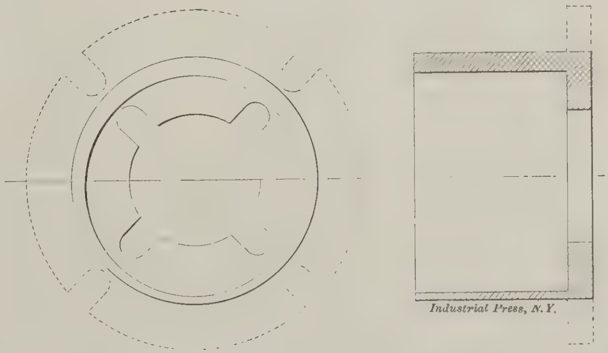
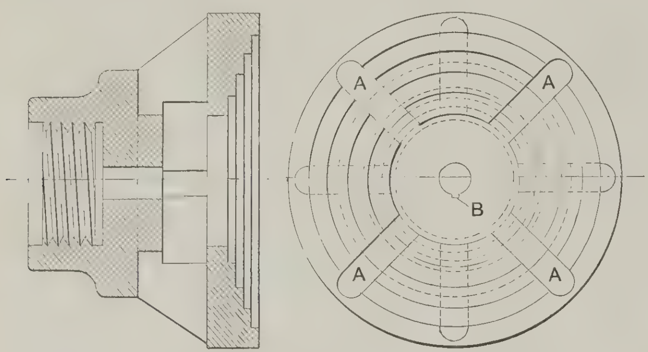


Fig. 1. Casting for Piston Rings.

The tools consist of a bell chuck, cutter head and boring bar. The casting from which the rings were made is shown in Fig. 1 and has a small flange 1 inch wide on the inside for clamping them to the chuck. On the smaller sizes this flange is on the outside, as shown by the dotted lines. There are four slots cast in the flange which correspond with the slots in the bell chuck, thus doing away with the necessity for drilling bolt holes or for removing the nuts from the bolts in order to remove or replace the work. The bell chuck, shown in Fig. 2, is fitted to the spindle of the lathe and has a series of counterbored seats in the face to receive the different sizes of ring castings. The slots for clamping the bolts, above referred to, are cast at *AA* and are of sufficient length to accommodate all of the sizes of rings.

The boring bar, shown in Fig. 4, is made of a piece of 1½-inch tool steel turned down at the ends to a diameter of 1⅜ inches. These turned portions are eccentric with the remainder of the bar so that when the bar is held by the ends it will have a throw of ⅛ inch. The shorter end has a feather key to correspond with the keyway in the chuck, at *B*, so that the bar revolves with the chuck and the work. The turret head is bushed to 1⅜ inches to receive the long end of the bar.



Industrial Press, N.Y.

Fig. 2. Bell Chuck for Turning Piston Rings.

The cutter heads, of which there are two, a rougher and a finisher, slide on the bar and have a compound movement due to the eccentric motion of the bar as it travels with the work and to the sliding movement of the turret as it feeds it along to the work. The eccentric motion of the bar causes the cutting tool to advance and recede from the work and thus bore a hole that is ⅛ inch eccentric with the outside of the ring which, at the same time that the boring is in progress, is being turned on the outside with an ordinary turning tool. A slot at *C* in the cutter head, Fig. 3, engages with a lug in the face of the turret and thus prevents the cutter head from turning with the work, at the same time allowing it to move freely with the motion of the bar.

When the casting has been roughed out the bar is withdrawn from the chuck a sufficient distance to allow the roughing head to be removed, and the finishing head is substituted.

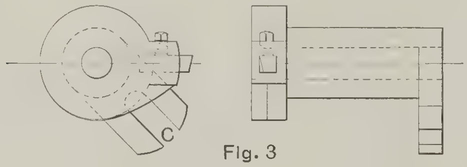


Fig. 3

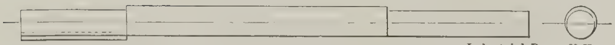


Fig. 4

Industrial Press, N.Y.

Figs. 3 and 4. Cutter Head and Bar for Boring Piston Rings.

The ring is then simultaneously finish turned and bored in the same manner in which it was roughed out. A gang tool is used to cut the rings off to the proper width, two rings being cut off at a time. This operation completes the rings and the time occupied is about one-half that formerly required when they were finished by first boring the casting and then shifting the amount required for the eccentricity and turning on the outside. The tools here described were made to fit a 24-inch turret lathe but any stout lathe with turret attachment can be used just as well. H. H. Esbenshade.

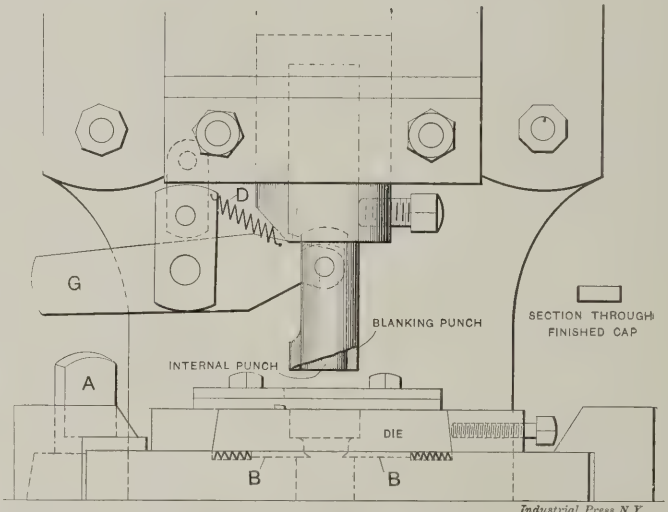
Waynesboro, Pa.

A DOUBLE-ACTING PUNCH FOR A SINGLE-ACTING PRESS.

Editor Machinery:

The writer recently had occasion to make 4,000 small brass caps of the shape shown at the right in the accompanying drawing. Having no double-acting press on which these could be punched and drawn simultaneously the method first suggesting itself was to make them in two operations, blanking them out first and then drawing in a second operation. But, as this would entail a double amount of work, after a little consideration the punch here illustrated was designed for punching and drawing the work on a single-acting press, in the same manner in which it would have been done on a double-acting press had one been available.

The die is made in one piece, similar to the ordinary die used on the single-action presses, the only difference being a deeper recess for the blanking punch in order to give a sufficient throw to the internal punch for it to force the cap through the bottom part of the die. As the brass was but No. 24 gage it did not require very great pressure to draw the cap up to the required 5-32 inch in length. When the piece was blanked, the punch was flush with the die and the lever *G* had just come into contact with the stop *A* which, as the punch continued to descend, caused the internal punch to move forward ahead of the blanking punch and force the punching through the die, thereby forming the cap in a single operation. As the blanking punch was withdrawn the strippers *B B* relieved the cap from the internal punch and the spring *D* returned it to its original position within the blanking punch. Geo. C. Reith.



Industrial Press, N.Y.

A Double-acting Punch.

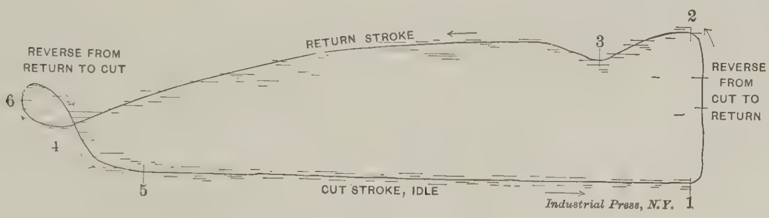
Philadelphia, Pa.

PLANER INDICATOR DIAGRAMS.

Editor Machinery:

The advent of individually motor-driven machine tools has, by direct electrical measurements and readings from dial instruments, resulted in a ready determination of the power required to drive them. This has been very satisfactory for those tools in which the power consumption varied but slowly, but less so with others, such as planers, with which the rapid changes at the ends of the stroke made accurate readings of the fast moving needle rather difficult. On studying the influence of belt speed and shifting rate on the action of the planer it became plain that a power diagram, analogous to that used in steam engines, which would give a graphic picture of the occurrences throughout the stroke, and more particularly of those at reversal, would be very desirable. An electrical instrument maker undertook the building of suitable apparatus which consisted of a special type of amperemeter, with a recording drum, etc., arranged very much as the usual engine indicator. The drum, carrying the paper, was rotated from the planer table through a reducing gear. As the makers thought that the friction of the pencil would too seriously dampen the action of the ampere meter needle, this was brought into contact with the paper at short intervals only. A stirrup, wide enough to cover the entire field of the needle, was from time to time depressed by clockwork and in turn insured the momentary contact of the pencil carried by the needle. This explains the peculiar appearance of the diagram, which is made up of a series of horizontal dashes; the one shown representing a number of consecutive table strokes. The continuous curve was drawn in by hand. The general outline is characteristic of all obtained on various planers.

The power taken on the cut stroke, idle, is constant. At 1 a very rapid power increase is started to reverse the table to the return; the almost vertical rise shows that it is very sudden. Then a gradual fall of power takes place during the whole of the return stroke, except near the start, where there is, from 2 to 3, a peculiar dip and recovery. The absence of a steep peak at 2 shows that the width and speed of the belt have been well chosen and that the reversing cam has been correctly designed, all working together harmoniously. It is natural to expect that, once the return is well started, the power would remain fairly constant to the beginning of the next reverse; but the diagram shows a continuous drop; this is characteristic of all tests made on other sizes of planers also, and an appearance which the writer is at a loss to satisfactorily explain. At 4 the change into the cut stroke begins to make itself felt by an increase of power beyond the actual reverse; the power then gradually and smoothly drops to that taken throughout the cut stroke. It is the continuance of the power rise beyond the actual reversal that causes the rather unexpected loop at this end of the diagram. This also is a general characteristic. Though at first sight this loop appeared anomalous a little reasoning shows it to be expected. To overcome the inertia of the fast running pulleys in reversing them calls for an increase of power; as the beginning of the reverse takes place during the return stroke the power must rise near the latter's end, attain a maximum at about the time when the reversal has been effected and then fall. As the power during the cut is less than during the return the curves must cross and form a loop. At the change from cut to return the same phenomena occur, but manifest themselves as a dip instead of a loop, because the power required at the beginning of the return does not fall as low as that taken by the cut stroke, so that the curves, though approaching, do not cross to form a loop; the action at both ends is similar, varying only in degree. The motors used were all of the three-phase, alternating current type, with 50 periods per second.



A Typical Planer Indicator Diagram.

Philadelphia, Pa. HENRY HESS.

ANOTHER METHOD OF TURNING A BALL.

Editor MACHINERY:

The writer has read with much interest the article in the June number of MACHINERY upon the subject of ball turning. In the shops of Messrs. Richard Pohle & Co., Riga, Russia, many balls are turned, for valve purposes, in what is believed to be a faster and more accurate method than that described by Mr. Otis. The balls are first turned on centers to a diameter about 1-64 inch greater than the finished size and as nearly round as possible. The centers are then cut off and the balls finished in the arrangement shown in the photograph, Fig. 1.

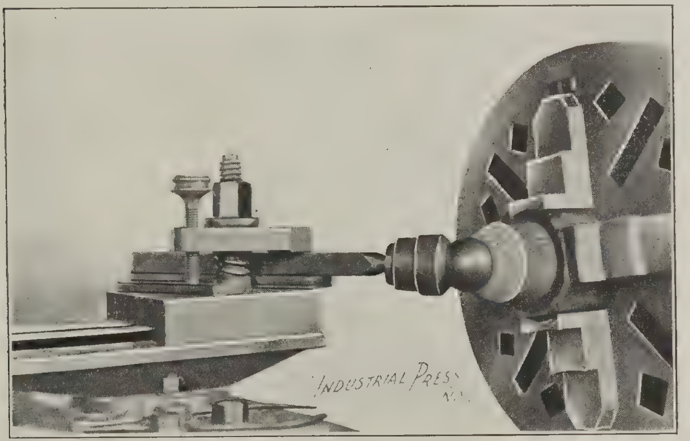


Fig. 1. Another Method of Turning a Ball.

A piece of hard wood is put in the chuck and bored out to fit nearly one-half of the ball. The finishing tool consists of a single piece of steel bored out to a diameter of from 55 to 66 per cent. of the diameter of the ball. The cutting edge at *AA*, Fig. 2, must be very sharp and perfectly circular, and when grinding is necessary, it should be done on a machine to insure accurate results.

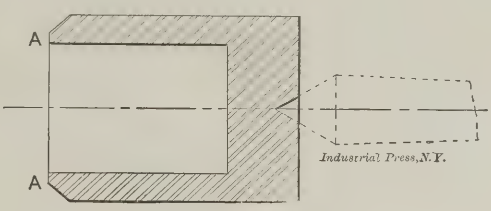


Fig. 2. Tool used for Ball Turning.

The ball is placed in the wooden chuck and the tool pressed against it at an angle of about 45 degrees. While revolving, both the ball and the tool will rotate against one another and in a short time the ball will be cut perfectly round and smooth. Naturally, both ball and tool will heat very considerably, so that it is necessary to cool the ball in water. It is, therefore, a good plan to turn two balls at once so that one may be cooling in the water while the other is in the chuck. This method has been employed for a number of years and has always produced very good results. The photograph was taken when turning a ball 2 inches in diameter. A. WIND.

Riga, Russia.

FACING AND COUNTERBORING LARGE SPIDER CASTINGS IN THE DRILL PRESS.

Editor MACHINERY:

In a shop where paint mixing machines are built the writer came across a method of facing and counterboring large castings in the drill press which may prove suggestive to readers for the machining of other work in a like manner. An idea of the shape and size of the castings may be gained from Fig. 1, in which is shown the nature of the work to be done. As will be seen the casting has two hubs which are required to be bored to a finished diameter of 5 inches, then faced at *AA*, *BB*, *CC*, and *DD*, respectively, and lastly counterbored at *FF* to a depth of 1 inch and a diameter of 7 inches. It is at once obvious that the large drill press which is equipped with a floor base is the proper machine for the work, and that it would be very difficult to do the work in any other machine.

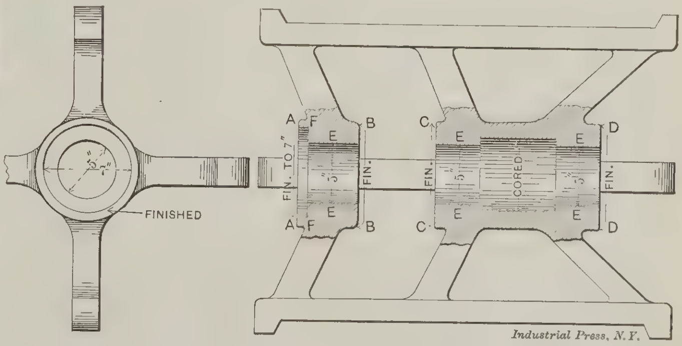
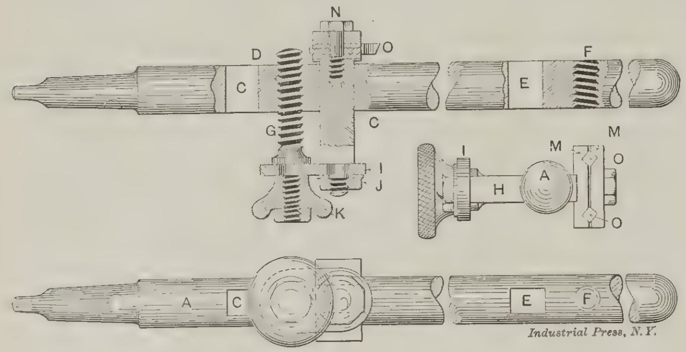


FIG.1. CASTING AS BORED, FACED, AND COUNTERBORED.

The boring to a finish of the cored holes in the hubs presented no unusual difficulties; a large boring bar of approved construction being used and the projecting end allowed to run in a bushing, bolted to the floor base of the drill, to which the work was strapped. To accomplish the facing of the four hub faces and the counterboring of the seat in an expeditious and accurate manner, however, required other means than those used for the boring. It was for this work that the special facing and counterboring tool illustrated in Fig. 2 was used.

As will be seen the special tool consists of the regulation bar, turned taper at one end to fit the drill press spindle, and rounded at the other to enter easily the supporting bushing on the base of the press. This bar has five holes let through it to accommodate the boring head. The holes are indicated in the engravings by letters *C*, *D*, *E* and *F* respectively. Three holes are for the cutter bar and the other two are tapped holes for the feed screw *G*. In the cutter head, *H* is the bar, *O* the "goose neck" cutting tool, a seat for which is provided in the cutter clamps *M* at either side of the center as the taking of under and upper cuts necessitates. *I* is the connecting strap between the cutter bar and the feed screw; *J* the bar-fastening nut; *G* the feed screw and *K* the hand knob. *N* is a cap screw used for fastening the cutter and cutter straps to the cutter bar.

In using this tool the bar was projected down through the hubs of the casting until the end ran in the supporting bushing at the base. The cutter head was then in the position shown in Fig. 2. First the surface *A* was faced, the feed screw being turned a little by hand at each revolution—the large opening making this an easy matter. Next the seat *FF* was bored and finished in the same manner, feeding the spindle of the drill down for depth and the feed screw of the cutter head for diameter. After this the under face of the upper hub was faced by removing the cutter head entirely; feeding the spindle downward until the upper three holes in the bar were clear of the under face of the upper hub; then relocating the cutter head with the feed screw in the same hole as it occupied in the first instance; but with the cutter bar in the upper hole *C*. Thus the cutter bar was merely reversed and the facing of the under side of the hub accomplished by feeding the spindle up instead of down. The two faces of the lower hub were faced in the same manner, the cutter head being removed and reversed as required.



Industrial Press, N.Y.

Fig. 2. Facing and Counterboring Bar.

J. V. Woodworth.

Brooklyn, N. Y.

THE STRENGTH OF GEAR TEETH.

Editor Machinery:

From time to time much valuable information has been published in the columns of Machinery relative to the strength of gear teeth; and the formulas by Mr. Wilfred Lewis, reproduced in the July data sheet, accompanying the Engineering Edition, are very valuable to those who have to make calculations concerning the strength of the standard gears—or rather the safe load, as the formulas do not give the ultimate strengths.

In one case, however, which recently came to the writer's attention the Lewis formulas did not seem to call for a gear strong enough for the given purpose. In this case the writer was called upon to design a large cast-iron gear to run at a speed of 100 feet per minute and to carry an extremely heavy load. Lewis' formulas having been used with good results at higher speed, it was natural to suppose that they would apply equally well to this case. As this gear was too large for the shop to handle the design was submitted to several of the parties who make a specialty of large gear work and their opinion was asked as to its fitness to stand the load for which it was designed. Without exception they replied that the gear was not strong enough for the required duty and when the gear tooth was calculated as a cantilever beam, assuming the load to come at the top of the tooth, it was decided that the proper factor of safety had not been allowed.

The writer then began to study the subject more fully with the object of finding a formula which would give the ultimate strength as well as the safe load, so as to be able to vary the factor of safety to suit the given case, and also to calculate the strength of tooth when made shorter than the standard depth. There are so many rules for the strength of gear teeth that there is probably much truth in the statement made in Grant's gear book that, "If a gear tooth should break, the designer can always find a rule to prove that it must have met with an accident, as it was properly designed." It seems to me that the best way to treat this subject is to first calculate the ultimate strength of the tooth and then divide by the proper factor of safety to get the safe load at the pitch circle.

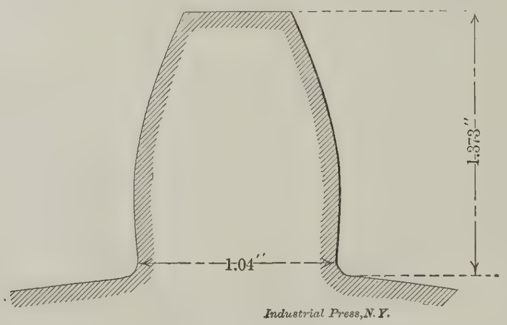
Among Cooper's collection of 24 rules from different writers, published in the *Journal of the Franklin Institute*, July, 1879, will be found the following method, which was used by James Watt to find the ultimate strength of cast-iron gear teeth. He found that a bar of 1-inch square cast-iron would break if a load of 600 pounds be applied at a distance of 12 inches from the point of support; then if the load was applied at 1 inch from the point of support, the bar would break with a load of $12 \times 600 = 7{,}200$ pounds. Hence the following formula for the ultimate strength of cast-iron gears:

$$U.\,S. = \frac{7{,}200 \times (\text{thickness of tooth at root})^2 \times \text{length of face}}{\text{full depth of tooth.}}$$

For example: What would be the ultimate strength of a cast-iron gear tooth of 2-inch circular pitch, 5-inch face; the gear having 30 teeth? The figure shows the thickness of the tooth at the root to be 1.04 inch and the depth of tooth 1.373 inch. Then:

$$U.\,S. = \frac{7{,}200 \times (1.04)^2 \times 5}{1.373} = 28{,}300 \text{ pounds.}$$

This rule, however, would require cast-iron to have an ultimate strength of flexure of 43,200 pounds, whereas for ordinary cast-iron most authorities give 36,000 pounds per square inch. Assuming the latter value and calculating for a beam of 1 inch square section and 1 inch deep, we have:



Industrial Press, N.Y.

Tooth of Gear used in Example.

$W\,l = S\,R.$

$W =$ Breaking strength in pounds.

$l = 1.$

$S = 36{,}000.$

$$R = \frac{(\text{side of square})^3}{6} = \tfrac{1}{6} = \text{moment of resistance.}$$

Then

$$W = \frac{36{,}000}{6} = 6{,}000 \text{ pounds}$$

and for safety, unless the ultimate strength of flexure is known, it would be better to use 6,000 pounds in the formula in lieu of 7,200 pounds.

Substituting this value in the above example the ultimate strength of the tooth would equal

$$\frac{6{,}000 \times (1.04)^2 \times 5}{1.373} = 23{,}600$$

Whenever the ultimate strength of flexure is known for any material, take one-sixth of the value for use in the formula.

Having found the ultimate strength of the tooth, the next step in order is to find the safe load. This would depend upon the speed at the pitch circle; for as the speed increases, the liability of the tooth breaking from shock becomes greater. The following factors of safety and corresponding speeds have been computed by the writer as giving good average results:

Speed of teeth in ft. per min.	100 or less	200	300	400	500	600	900	1200	1800	2400
Factor of safety.	3½	4½	5½	6	6¼	6½	8½	11	13	15

For example: What is the safe load of the above gear running at 20 revolutions per minute, taking 36,000 pounds as the ultimate strength of flexure?

$$\text{Speed in feet per min.} = 20 \times \frac{2 \times 30}{12} = 100$$

Corresponding factor of safety = 3½.
Then

$$\text{Safe load} = \frac{23,600}{3.5}\ 6,743 \text{ pounds.}$$

The safe load for this gear as figured by Lewis' formulas would be:
$8,000 \times 2 \times 5 \times .102 = 8,160$ pounds, indicating a considerable less factor of safety than when figured by the other formula. Some authorities claim that cast-iron should never be strained beyond one-third of its ultimate breaking strength, as that is the elastic limit for the material.

For the same gear in steel having an ultimate strength of flexure of 120,000, the ultimate strength would equal

$$\frac{\frac{120,000}{6} \times (1.04)^2 \times 5}{1.373} = 78,660 \text{ pounds,}$$

and the safe load would be

$$\frac{78,660}{3.5} = 22,474 \text{ pounds.}$$

Lewis gives for a safe load for steel 20,000, so that by his formulas the safe load would be $20,000 \times 2 \times 5 \times .102 = 20,400$ pounds, giving in this case a smaller value than that obtained by the other formula, therefore indicating that a greater factor of safety has been used. J. T. Giddings.

East Providence, R. I.

[In the above discussion of the strength of gear teeth no consideration has been taken of the shape of the tooth, the weakest point being assumed in all cases to be at the root of the tooth. In Mr. Lewis' investigation he systematically determined this point from a series of drawings of involute cycloidal and radial flank teeth and his formulas, based upon this investigation, are generally accepted as the most reliable data at present published concerning the strength of gear teeth. They are, however, open to criticism in the matter here referred to, in that the strengths of iron and steel are assumed and the results given in safe strengths. If in the place of the values *S* given by Mr. Lewis we substitute the ultimate strength of the material considered there is no doubt that the formulas will give more reliable values for the strength of the three forms of teeth considered than any other method of calculation. For special forms of teeth, stub teeth, etc., it is sufficiently accurate to figure them as a simple beam with the weakest point at the root of the tooth; for whatever error may then occur will be upon the safe side for strength, and for the investigation of gear teeth in this manner the formulas here presented by Mr. Giddings will be found perfectly reliable and in very convenient form for use.—Editor.]

A MILLING FIXTURE.

Editor Machinery:

The piece shown in Fig. 1 is a latch chuck, made of cold rolled steel, that is used on a special machine for holding the ends of rods. The body and the center holes on both ends were turned in the lathe and the other holes were drilled in a special jig. The fixture shown in Fig. 2 was designed for holding the chuck while milling the longitudinal slot to receive the latch which was required to be exactly central with the axis of the piece. While not of unusual design, it possesses some advantages that make it especially useful when it is necessary to perform milling operations of this nature. It is so made as to be free from any outside incumbrances and the parts where wear is likely to become appreciable are carefully hardened. The clamping mechanism is of a gradual wedging action thereby holding the work securely and at the same time permitting the quick removal of one piece and the insertion of another by simply turning the milled knob to the right or left as may be desired. As will be seen, the clamping mechanism is entirely enclosed, thus avoiding dust and dirt and lessening the liability to accident from any external cause. While the illustration shows only one way in which this device may be employed, a wider field of application will without doubt suggest itself to the reader, as it is suitable for holding all kinds of milling jobs, especially where the work is polished and would be marred by clamping in a vise in the ordinary manner.

The fixture is made of liberal proportions, to insure rigidity, and is tongued and slotted for clamping bolts. Through the center of the body of the fixture is drilled a hole carrying the tightening clamp *B*, the larger diameter of which fits snugly in the hole while the neck is turned down and threaded to fit the clamping knob *C*. To prevent the piece from turning, when the knob is turned, a groove is cut the entire length of the larger diameter and into this fits the point of the setscrew *D*. The upper face of *B* is milled flat on a taper of 1 inch per foot and this part of the piece is made very hard. When clamping the work, the shoulder of the knob brings up against the body of the jig at *E*; on reversing, the two screws *FF*, with their points seated in a rounded groove in the knob, prevent it from being withdrawn.

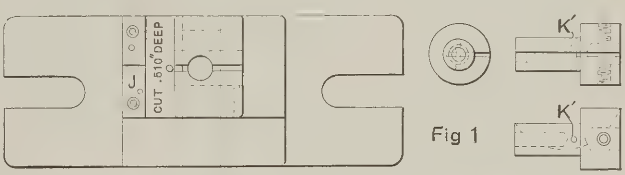


Fig 1

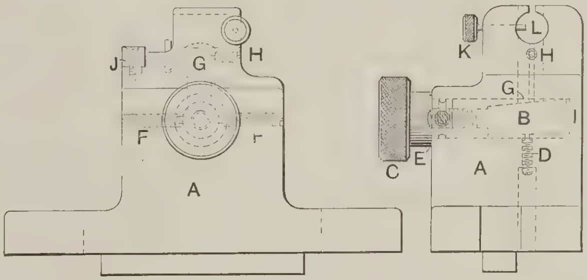


Fig.2

Industrial Press, N.Y.

Fixture for Milling Slot in Latch Chuck.

The semi-circular faced plug *G* stands vertically in the position shown, one end resting on the inclined face of *B* and the other bored out to conform to the diameter of the work. A spline is cut on one side to receive the point of the screw *H* which, while permitting a free movement up and down, checks any tendency for the piece to rotate. This plug fits the hole so freely that when it is released it falls away from the work by gravity. When the parts of the fixture are assembled the chamber in which the slide *B* is located is filled with vaseline and the plug *I* driven in, thereby completely enclosing the mechanism and preventing the ingress of grit or the escape of oil.

The milling of the slot in the work is performed with an ordinary metal saw of the required width; setting it central is simplified and facilitated by the set gage *J*, which is of tool steel, hardened and fastened in place with screws and dowel pins. The depth to be cut is measured by the graduated dial on the milling machine. In this case it is .510 inch, and this is stamped upon the fixture for convenience of future reference. To operate the fixture the pin *K* is withdrawn a sufficient amount to clear the hole *L* and the nose of the chuck to be milled is inserted against the stop pin. The chuck is rotated by hand, at the same time pressing upon the head of the pin *K*, until the pin slips into the fulcrum pin hole for the latch, K^1, Fig. 1, that has been previously drilled in the work. A turn of the knob *C* then clamps it tightly for the milling operation. C. H. Rowe.

Salem, Mass.

A NEW FORM OF FRICTION CLUTCH.*

The friction clutch is a very old invention, and is probably as familiar to every one in its simplest form as any other machine detail. It is, however, only in recent years that inventors have, in any great numbers, seriously attempted to overcome the defects of the ordinary cone clutch, and their attempts have been attended with such success as to lead to the introduction of a very large number of clutches of moderate power into machinery. This is proved by the fact that in recent years a good many engineering workshops have been devoted, either wholly or in part, to the manufacture of clutches of certain well-known forms. A number of such makers have supplied clutches for many thousands of horse power for purposes in which they were little used a few years ago. A familiar illustration is the extensive introduction of friction clutches to countershafts in place of the ordinary fast and loose pulley. It might therefore be thought at first that, in an apparently simple matter, there was very little more to be said and nothing more to be discovered. The importance of the friction clutch, however, justifies a very careful consideration of the problem, as to whether, in view of the modern developments of motive power, particularly in internal-combustion engines and of high-speed machinery of great power, there are not yet improvements possible in this subject.

FIG. 1
CONE CLUTCH

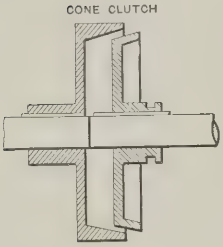


FIG. 2 RIM CLUTCH

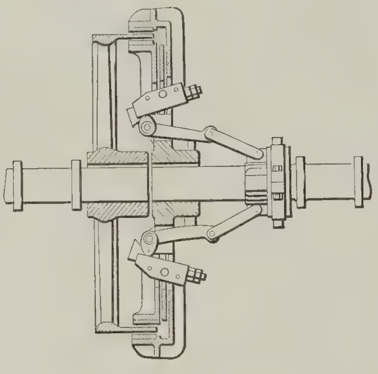


FIG. 3
DRUM EXPANDING CLUTCH

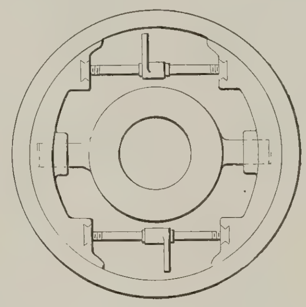


FIG. 4
BRUSH CLUTCH

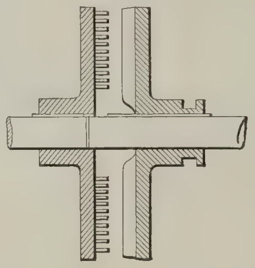


FIG. 5
COIL CLUTCH

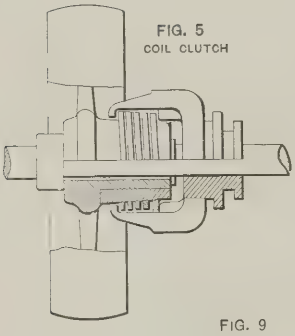


FIG. 6
"WESTON" CLUTCH

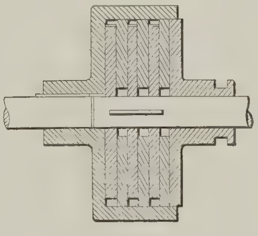


FIG. 7
ORDINARY ARRANGEMENT OF CORRUGATED PLATES

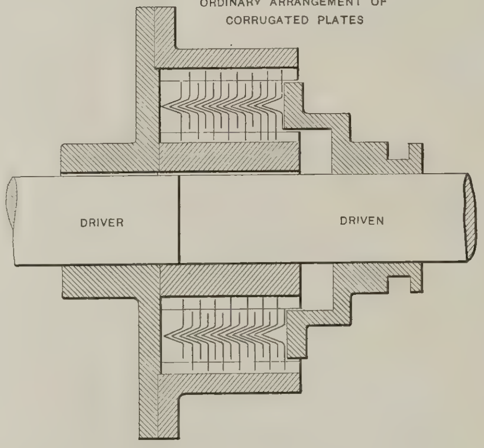


FIG. 8
CIRCULATION OF LIQUID WITH VARYING ANGLES OF PLATES

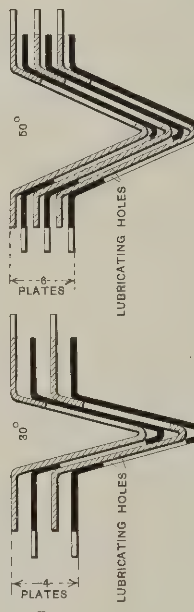


FIG. 9
HOLES IN CORRUGATIONS, FOR CIRCULATION OF LIQUID

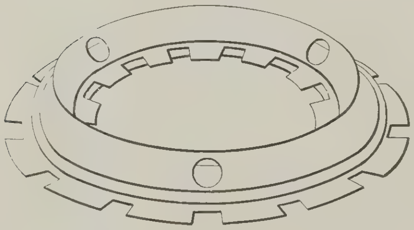
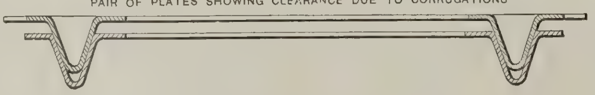


FIG. 10
PAIR OF PLATES SHOWING CLEARANCE DUE TO CORRUGATIONS



Industrial Press, N.Y.

The usual object of a friction clutch is to impart motion from a piece of machinery to another piece of machinery at rest, and thus the friction clutch differs in its object, in a very essential manner, from any ordinary form of coupling, or from the well-known jaw clutch. In the latter there is not—or should not be—any relative motion between the parts connected. Hence the strains involved are of a statical nature, and, however great, do not involve a mutual action of the nature of a shock, whereas where two pieces of machinery, not having the same speed, have to be connected with each other, there would be a shock due to inertia, unless the connection was made by means of a friction clutch, or some equivalent, such as a slipping belt, allowing the two pieces of machinery to gradually come to the same speed. This gradual effect is therefore the primary object of the friction clutch, and how important this object is, will be realized when it is remembered that it is impracticable to start any machine instantaneously, for the magnitude of the stresses and strain caused when a machine is set in motion by another, increases with the suddenness of the operation, and all appreciable shock can be obviated by allowing the action to take place gradually.

During the whole time that the two pieces of machinery are coming to one speed—which in the case of the friction clutch is caused by one starting another into motion, while in the case of a brake it is caused by one bringing the other to rest—during this time work is being lost at the surfaces where the slipping is taking place, and consequently heat is generated. The more gradual the action, therefore, the greater the amount of heat, which reaches its greatest amount in the case of the friction dynamometer, where slipping takes place the whole time, and all the work of the moving machine is converted by the friction into heat. Further, it may be said—speaking practically—that wherever there is friction between two surfaces, there is a certain amount of wear taking place, which may be diminished by the use of suitable lubricants. The better, however, the surface is lubricated, the less the effect of friction, and consequently the less the gripping power of the clutch.

Stated briefly, the four conditions which seem to be involved in the problem of the friction clutch are:

1. It must have sufficient gripping power.
2. Undue wearing of the surfaces must be avoided.
3. Provision must be made for conveying away the heat where there is much slipping contact in the clutch.
4. Motion should be imparted to the driven shaft without shock.

We are thus met at the outset with the contradictory conditions which have made the problem of the friction clutch such a difficult one. The author does not remember seeing in any previous writings on the subject, or in the statement of inventors themselves, the important fact mentioned in condition 3, but it certainly does account for the large number of instances in which friction clutches have failed to give satisfactory results for anything but the smallest powers.

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* Paper read by Prof. H. S. Hele-Shaw before Institution of Mechanical Engineers, Leeds, England.

Looking at the various clutches in use they may be classified and represented diagrammatically as follows:

1. The cone clutch, Fig. 1, where considerable pressure between the surfaces is obtained by the wedge action of the cone.
2. Various forms of rim clutch, Fig. 2, in which the action is obtained by means of levers.
3. Clutches with rings or segments expanding within a drum or annulus, Fig. 3.
4. The brush clutch, Fig. 4, in which brushes of wire are thrust into a finely serrated or grooved plate.
5. The coil clutch, Fig. 5, in which a coil of metal or wire rope with blocks is employed to give great gripping power.
6. The "Weston" clutch, Fig. 6, in which the friction effect is produced by a number of circular disks connected alternately with the driving and driven machine.

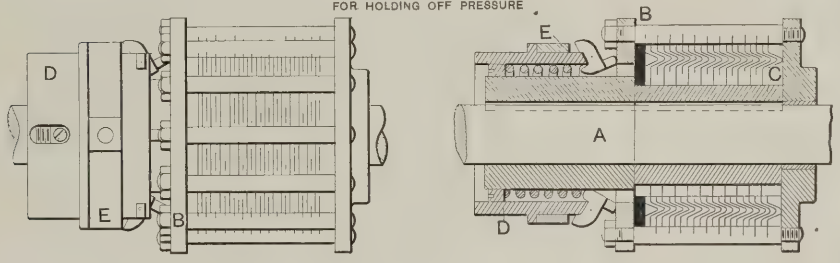

FIG. 11
TYPE OF OPEN CLUTCH WITH AIR COOLING. SHOWING TRIGGERS FOR HOLDING OFF PRESSURE

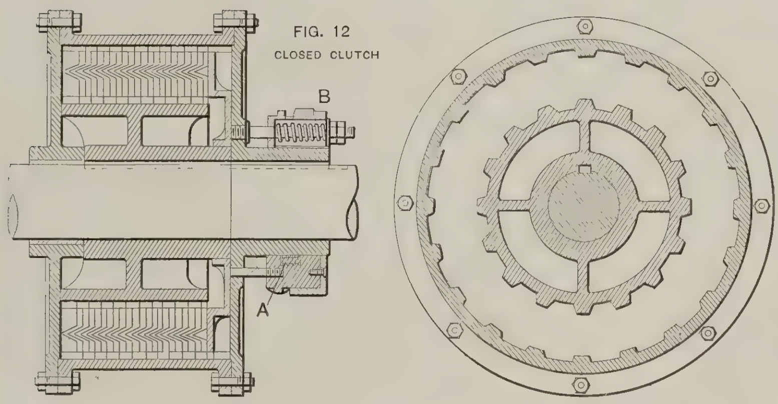

FIG. 12
CLOSED CLUTCH

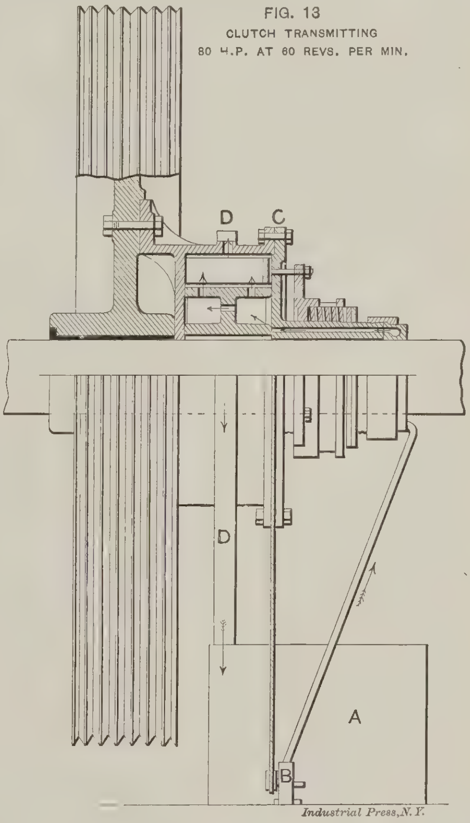

FIG. 13
CLUTCH TRANSMITTING 80 H.P. AT 60 REVS. PER MIN.

Industrial Press, N.Y.

There are numerous modifications in detail of all these clutches, but the inventions in connection with them—which are very numerous—relate principally to the mode of obtaining the requisite pressure between the friction surfaces. Thus taking the case of the expanding ring or segment, which is one of the most successful forms, wedges, right and left-handed screws, and toggle-joints have all been used in different ways for expanding the rings or segments; but no clutches appear to have been designed for the purpose of allowing slipping to take place to any considerable extent, so as to prevent, at the same time, undue wearing and heating of the friction surfaces. These clutches, if not transmitting considerable power and not required to slip, serve their purpose very well. Some, such as the coil clutch, the "Weston" clutch, and the expanding ring clutch, may be made to transmit great powers, but it may be safely said that not one of the foregoing clutches has yet been designed so as to be capable of slipping for more than a very short time, without being seriously injured, even if the surfaces in contact were not actually destroyed.

There are plenty of illustrations in mechanical science where it has hitherto been impossible to reconcile conflicting conditions, such, for instance, as the variable change speed gear, especially when required to be of high power and high efficiency, and it is an important question whether the present case forms another example or not. The author believes there is a way out of the difficulty, and this he proposes to bring forward in the present paper. It is quite possible that there are other ways, and if engineers consider the matter of sufficient importance, it may put them on the track of overcoming the difficulty by a way other than that which will now be described.

Suppose a sheet of metal is pressed into a frustum, the section of the corrugation being the frustum of a cone, and that the disk is placed upon another one similarly corrugated. It will be observed that not only do portions of the frusta not make contact with each other, but there is also a space left between the flat portions of the disks.

By placing these disks together as in Fig. 10 and turning one alternately to the other, an amount of friction is produced which depends on the acuteness of the angle of the frusta. If a number of these plates are now placed in a box of the type of the "Weston" coupling, so that the plates alternately engage with two sleeves, one connected with the driver and the other with the follower, as in Fig. 7, it will be found—first, there is very considerable gripping power; second, there is a tendency to part rapidly with heat, owing to the separation of the disks of metal.

By the ordinary theory of friction, the former effect—in a box of given length, if the gripping power is compared by actual measurement with the "Weston" clutch—will be found to be much greater, and yet this cannot be accounted for by the ordinary laws of friction, since the increased effect of the wedge action (which varies with the cosecant of the angle of the cone) is directly in proportion to the diminution in the number of plates which it is possible to put in a box, which diminution varies according to the same law. There is, however, a still more striking difference between the gripping action of the flat and corrugated plates when a lubricant is introduced.

Efficient lubrication of the surfaces in contact is insured by drilling the faces of the plates as shown in the sectional view, Fig. 8, and in the perspective view, Fig. 9. It will be noticed from this illustration that the number of plates in a given space depends upon the angle of the corrugation, thus: Four plates with 30 degrees occupy the same space as six plates with 50 degrees. These four plates, however, give a better grip than the six plates with 50 degrees, and have the great advantage of allowing a freer circulation of liquid, as may be easily seen from the figure. The plates are also much more rigid with the more acute angle.

Two views of a standard type of clutch for shafts up to 2 inches in diameter are shown in Fig. 11. The shaft is divided at A, the outside case B being keyed to the left-hand piece of shafting, and driving the set of plates having external driving teeth. The core C keyed to the right-hand shaft drives the plates with internal driving teeth. Pressure is applied to the plates as follows: The sliding sleeve D, containing a coil spring, is fitted with pins, which project through the outside case of the clutch; these pins press against a flat disk, which in turn presses against the plates, causing the clutch to drive. When the operating lever is worked so as to release the plates, the ring E encircling the sleeve withdraws the trigger pins from the holes into which they fit; the spring pressing on the opposite end of the trigger pin causes the trigger to fly up, and the clutch is thereby kept out of operation. By moving the lever so as to force the ring E against the trigger, the pin end falls into the hole opposite to it, and the coil spring is then allowed to transmit its pressure to the plates.

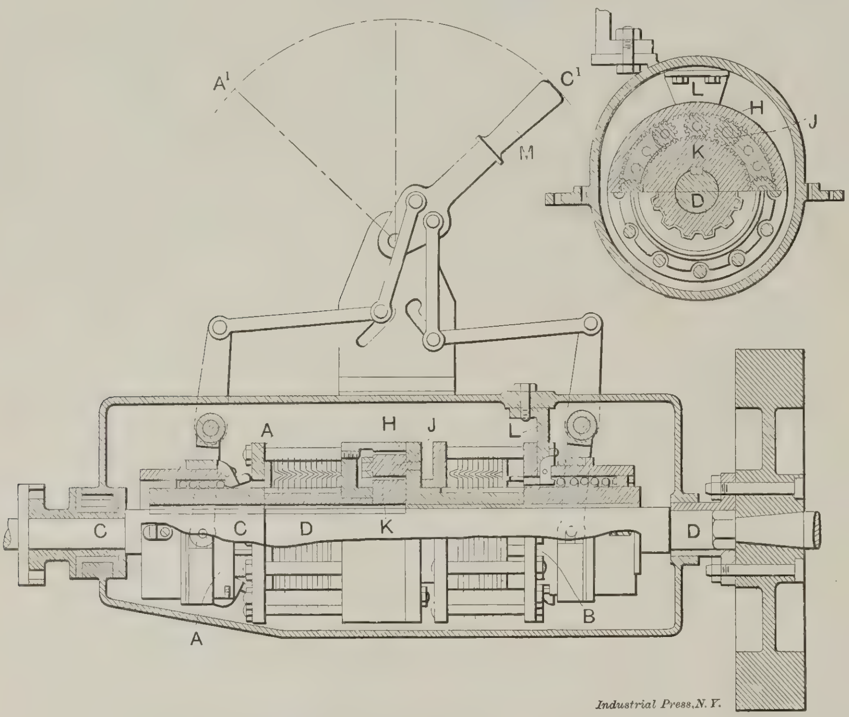

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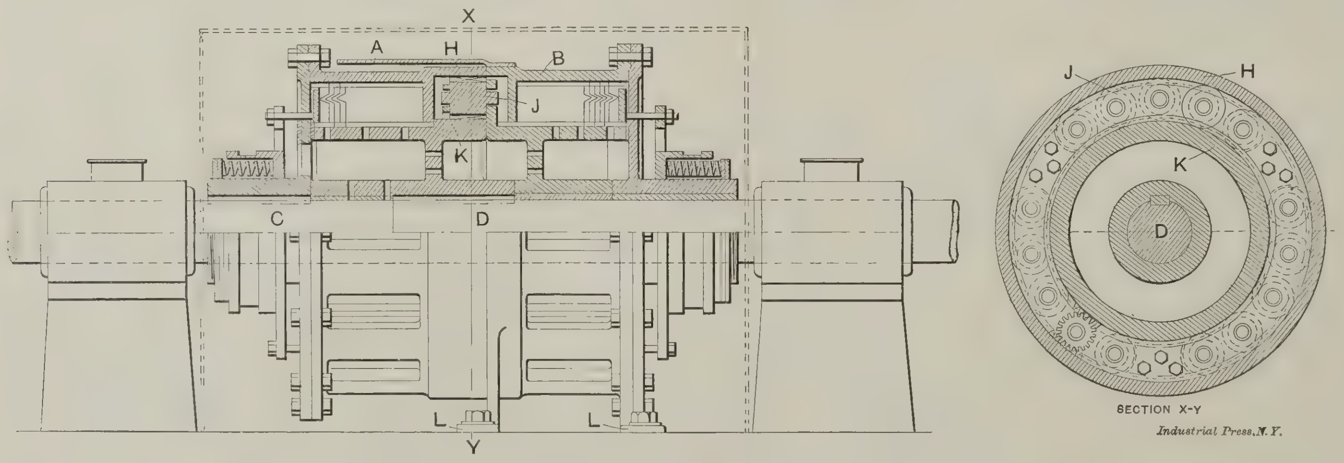
Fig. 14. Reversing Gear with New Form of Friction Clutch.



Industrial Press, N. Y.

Fig. 15. Reversing Gear with Friction Clutches, as applied to Steam Turbine.

Fig. 12 shows a section of a larger type of clutch as fitted to a 3-inch shaft. The action of this clutch is similar to that described in Fig. 11. The triggers, however, are worked by separate coil springs, A; the pressure is also applied to the plates by means of separate springs, B, instead of a single one, as in the type illustrated in Fig. 11. A considerable amount of lubricant can be contained in this clutch owing to the construction of the casing. The right-hand view indicates in section the form of driving teeth adopted.

A view of a clutch transmitting 80 horse power at 60 revolutions per minute is given in Fig. 13. One of the conditions of working of this clutch is that it should run for at least two hours daily transmitting only 30 horse power, the main shafting running at its full speed of 60 revolutions. It must pick up its load gradually and without shock. The cooling and lubricating fluid is contained in the tank A placed on the ground. The fluid is raised to the clutch case by means of the small rotary pump B, driven by a band from the clutch case at C, the path of the fluid being indicated by arrows. It leaves the casing through a series of holes in the periphery, being discharged through these by centrifugal action. It is then collected in the annular trough D, which, fitting loosely over the revolving casing, directs the fluid back into the supply tank A. This clutch has been at work at Pilkington's plate glass works, St. Helens, for a period of five months, running day and night, and fulfilling every requirement satisfactorily.

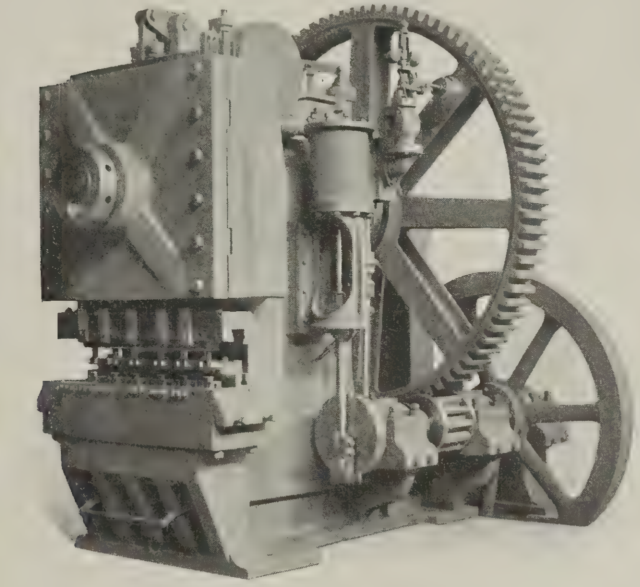
The clutch is the chief factor in a wheel train reversing gear, and the author has recently designed such a reversing gear in which the new clutch is employed. This reversing gear, shown in Fig. 14, consists of two clutches, A and B. The outer case of the clutch A is keyed to the reversing shaft C, which may be a propeller shaft, the core of A being keyed to the engine shaft D. Inside the rim of the outer case of A, teeth are cut in the direction of the shaft, forming an annular wheel H. To the internal core of clutch B a series of pinions are fixed, as shown at J; these pinions gear with the annular wheel H. They also gear with the wheel K, keyed to the engine shaft, the three together forming an epicyclic train. The outer case of B is held stationary, being fixed to the frame of the machine by a bracket L.

The gear operates as follows: When the lever M is in position C^1, clutch A is made free and clutch B comes into action. The core of B carrying the pinions J is now fixed to the outside case of clutch B (which is permanently at rest), and, as the core of B is free on the engine shaft, the toothed wheel keyed to this shaft at K transmits motion to the pinions, which, being also in gear with the outside case of A, causes the shaft C, to which A is fixed, to rotate in a reverse direction and at a slower speed than that of the engine. When the operating lever M is in mid-position, both clutches are inoperative and the reversing shaft is at rest. When the lever M is in position A^1, clutch B is free; at the same time the plates in clutch A are caused to grip, and as the outside case of A is keyed to the reversing shaft and the core of A to the engine shaft, the two rotate together in the same direction. The toothed gearing at H, J, and K now rotate as a fixed mass, the teeth themselves not being in operation.

The presser rings of clutches A and B on this gear are fitted with the spring and trigger arrangement described previously in connection with Fig. 11.

The locking system of operating links and levers renders it impossible for both clutches to grip simultaneously, no matter how suddenly the operating lever *M* may be moved from one extreme position to the other. The inclosing case of the whole gear acts as an oil bath, and thereby insures an efficient system of lubrication.

Fig. 16 shows the design of a reversing gear of this type for a steam turbine of 1,000 horse power, the number of revolutions per minute being 700 to 800. The action of this type of reversing gear may be made as quick or slow as desired, but with a fairly heavy flywheel attached to the gear it has been found possible to change from full speed in one direction to full speed in the opposite direction in five seconds.



Steel Splice Bar Press

A satisfactory clutch is one of the most difficult things to secure for automobile purposes. The ordinary type of cone clutch, which is generally employed, the cone of which is covered with leather, can rarely be maintained in a normal condition, for the following reasons: A great command over the car, especially in driving through traffic, is secured by allowing the clutch to slip. When slipping has been going on for some time the surfaces are generally so altered in their condition that either the clutch will not grip at all or it grips violently and harshly. The result in driving is not only most unpleasant, but it is very inimical to the car itself.

One of these clutches has been fitted to a fairly heavy car, on which the engines had been changed from 6 to 12 horse power. This clutch, although the plates were only 6 inches in diameter, drove the car so satisfactorily that the 6 horse power gear has, under very trying conditions of the British Association tests on road resistance, been found quite strong enough for the purpose. Since then the cone clutch of a 24 horse power Darracq car has been changed for one of the type here described, with remarkable improvement in its action. It has been found capable of driving the car so altered, although a fairly heavy one, for long distances, even in hilly country and without ever going off top speed, which is a direct gear to the driving wheels. The actual speed at the normal revolutions of the engine on this car is 70 kilometers (i. e., about 45 miles) per hour. This example shows the possibilities of the clutch, with which the car can be driven for any required distance at the speed of 3 or 4 miles per hour, or even less, and after running for an hour or two under these conditions the clutch does not get hot. Of course, the main object of the change gear, which is to increase the power if necessary, is not attained, since the slipping of the clutch can only involve loss of power; but this is a case in which, with an engine of sufficient power, variation in the range of speed is really a more important object than the saving in power.

* * *

A LARGE SPLICE BAR PRESS.

The use of steel in machine construction has of late been finding much favor with machine builders and an example of what may be accomplished in this direction is well illustrated by the splice bar press that has lately been built by the Long & Allstater Co., Hamilton, Ohio, and is illustrated in the photograph herewith. While the working construction of this press is not particularly out of the ordinary it is nevertheless quite remarkable for the materials that have been used and for the weight of the parts. The press complete has a total weight of 86,000 pounds and, with the exception of the engine, is made wholly of steel, the main casting alone weighing 43,000 pounds. The crankshaft is a nickel steel forging and all of its journal bearings are lined with bronze bushings. These bushings are required on account of the steel construction which makes it necessary that all working bearings must be lined with bronze to prevent the running of steel on steel. Consequently not only the shaft but the slide body, cam and cam pintle, which gives the movement to the slide, are all bronze bushed and the slide has bronze gibs for taking up the wear on the front, back and each side. The jaws on the clutch and wheel are faced with tempered steel plates, which may be removed and renewed when they become worn.

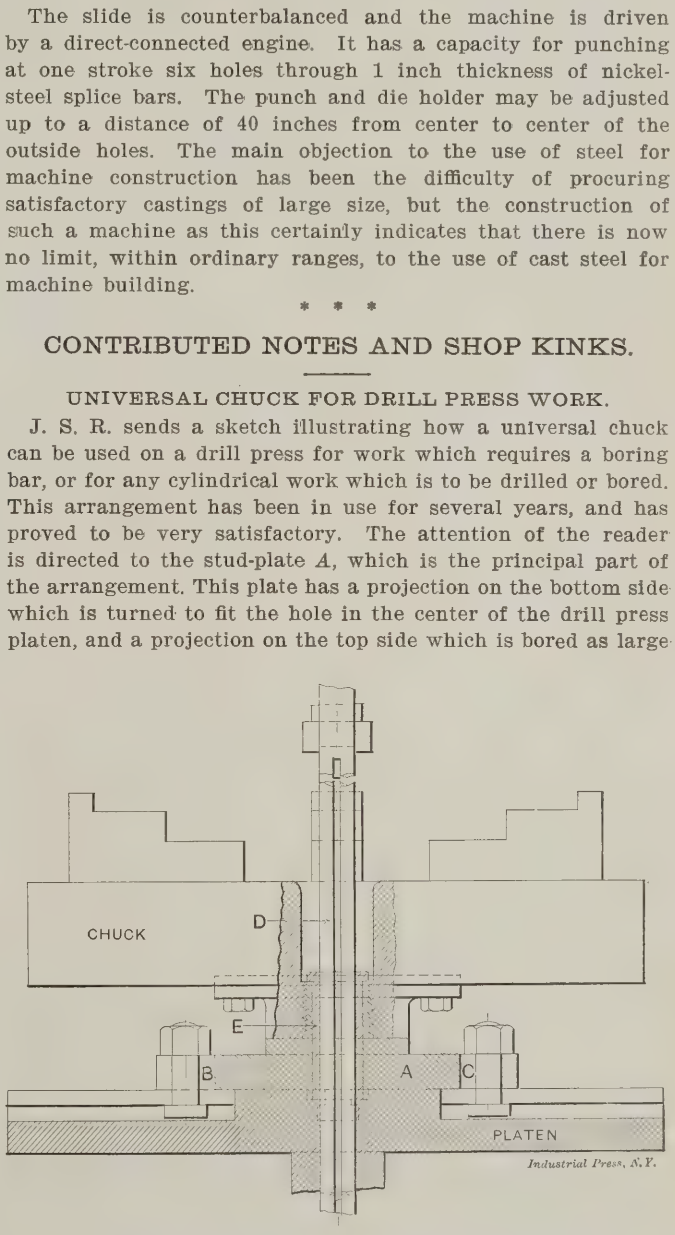
The slide is counterbalanced and the machine is driven by a direct-connected engine. It has a capacity for punching at one stroke six holes through 1 inch thickness of nickel-steel splice bars. The punch and die holder may be adjusted up to a distance of 40 inches from center to center of the outside holes. The main objection to the use of steel for machine construction has been the difficulty of procuring satisfactory castings of large size, but the construction of such a machine as this certainly indicates that there is now no limit, within ordinary ranges, to the use of cast steel for machine building.

* * *

CONTRIBUTED NOTES AND SHOP KINKS.

UNIVERSAL CHUCK FOR DRILL PRESS WORK.

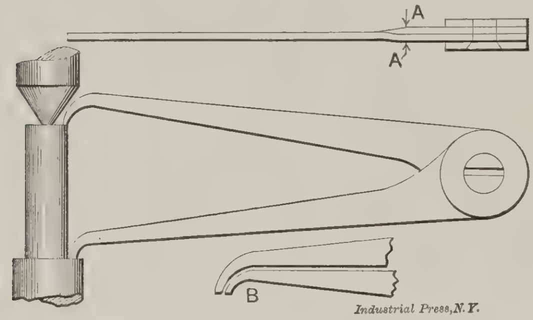
J. S. R. sends a sketch illustrating how a universal chuck can be used on a drill press for work which requires a boring bar, or for any cylindrical work which is to be drilled or bored. This arrangement has been in use for several years, and has proved to be very satisfactory. The attention of the reader is directed to the stud-plate *A*, which is the principal part of the arrangement. This plate has a projection on the bottom side which is turned to fit the hole in the center of the drill press platen, and a projection on the top side which is bored as large as the conditions will allow, and threaded on the outside to fit the threaded part of the faceplate of a universal chuck. This stud-plate is secured to the drill press platen by two bolts, as shown at *B* and *C*.



The bushing *E* is bored so as to be a good working fit on the boring bar *D*, and made to rotate with the bar by means of a key, which is fast in the bushing, but must slide freely in the keyway in the boring bar. If the boring bar has more than one mortise in it for cutters, the keyway should be cut from the lower end of the bar to the highest mortise. This bushing is turned on the outside so as to be a good working fit in the stud-plate, and should have a collar as shown at the upper end, which will, to a large extent, prevent dust and fine chips from getting into the working joint. By this arrangement the boring bar is supported at both ends, which insures greater rigidity, increase of feed, more stock removed in a given time, a greater variety of work, and as a consequence, more work done.

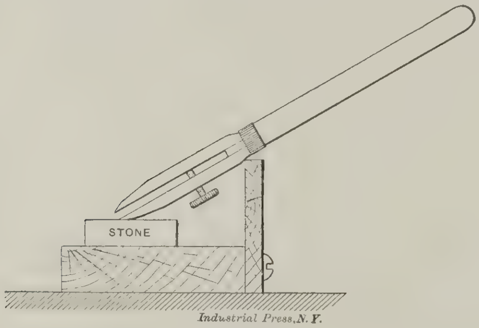
HOME-MADE SHOULDER CALIPERS.

V. H. M. sends a sketch of a pair of shop-made calipers which, he writes, have proved very handy in measuring work from shoulder to shoulder or from a shoulder to the end of the piece. For this purpose they are much handier and more accurate than the ordinary "hermaphrodites." The legs are bent at *A A* so as to lie flat and thus bring the point of the long leg directly behind the short one which "nests" into it, as at *B*, so that the calipers may be used for short measurements as well as for the long ones.



PEN SHARPENING ARRANGEMENT.

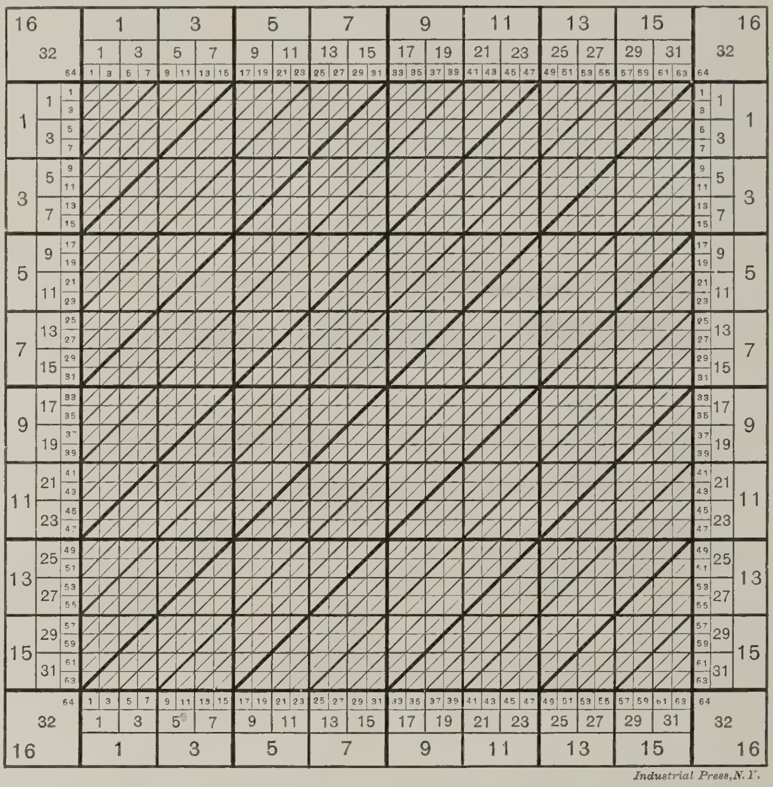
W. T. S. sends a drawing of a little arrangement that should prove very convenient in every drawing room. This is a device which he has used to facilitate the sharpening of drawing pens. A small wooden block, to which is attached a back, is all that is required. The stone is placed in any position desired and moved away from or toward the vertical back in order to bring the pen in contact at any angle that is wanted. The stone is held in place by the left hand, and the pen, held by the thumb and forefinger of the right hand, is moved backward and forward and at the same time given a rocking motion so as to grind all of the point. In this way first one and then the other nib of the pen are given an ideal finish.



ADDITION AND SUBTRACTION CHART.

L. S. Burbank, Worcester, Mass., sends us a chart that will prove of assistance to draftsmen and others in the addition and subtraction of fractional parts of an inch. The numbers in the smallest rows are 64ths of an inch and in the next larger rows 32ds and 16ths respectively, 8ths and larger fractions being located without indicating. One of the fractions to be added is located on the top of the chart, and the next number located on the left; trace the lines from these numbers vertically and horizontally to their intersection and then follow the intersecting diagonal line to the nearest side. The number there found is the sum of the two fractions. If this sum occurs on the right or bottom side of the chart, 1 must be added to the result. All numbers are traced on the line except 64ths, which, to simplify the chart, are traced between the lines.

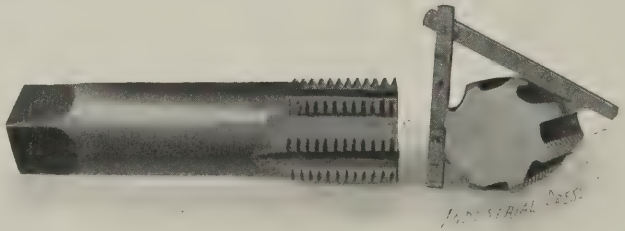
Example: Add 1¼ + 7-32 + 2⅛ + 53-64. The sum of the more easily computed numbers (1¼ + 2⅛) is found by inspection to be 3⅜. Continuing from here, find ⅜ on top of the chart, on third vertical line from the left. Note this point and find 7 in the 32ds row on the left; trace these horizontally and vertically to their intersection and then trace the intersecting diagonal, either way, to the edge of the chart, in this case pointing to 19 in the 32ds row. The result is now 3 19-32, but without stopping to learn this, note the point and find 53 in the 64ths row at the top. Trace similarly to their intersections, then the diagonal to 27, which is found in the 64ths row. As this occurs on the right or bottom of the chart, 1 must be added, making the required sum 4 27-64.



Any number of fractions may be added without stopping to learn the individual results, very much in the same way in which continuous calculations are performed upon the slide rule. As it does not matter from which side of the chart the numbers are found, the nearest one may be used for convenience. To subtract, trace *diagonally* from the larger number and *horizontally* from the smaller. Then from their intersection trace *vertically* to the same side on which the larger number is chosen.

ANNEALING A TAP.

H. H. E. sends us the accompanying photograph of a tap which was broken during the process of hardening. It was designed for a finishing tap, 4¼ inches in diameter and 22 inches long, and weighed 65 pounds. The forging was made from a bar of 4¼-inch carbon steel which was upset to a diameter of 4½ inches and thoroughly annealed. It was then machined to finished size without a second annealing but when the attempt was made to harden it, it broke in two, as illustrated. While there may be some difference of opinion as to just what caused this break there is but little doubt that the upsetting of a bar of steel is usually attended with disap-



pointing if not serious results in the finished tool. Where the nature of the work is such as to require that a tool like this be made from the solid bar, too much care cannot be exercised in forging and annealing the steel.

* * *

SPEEDS AND FEEDS.

E. R. MARKHAM.

For many years it has been a matter of study with the writer to harden tools in a manner that made it possible to run them at speeds, and to apply feeds, that insured the maximum amount of product. Many times, however, the matter of speed is given a great amount of attention, while other factors fully as important are lost sight of. I remember visiting a shop at one time where one man was running three lathes on very short cuts. The work being turned was run at a very high rate of speed. The foreman informed me that he had succeeded in getting a steel that would stand up when the work was run at more than double the speed he had formerly considered possible. Observation soon showed that the work was traveling at so high a speed that the entire length of the machined portion was traversed some little time before it was possible for the operator to tend to the other machines and get back to this one. Of course I realized that the proper method to pursue would have been to run the lathes at as high a speed as possible and then have sufficient help to take care of them as soon as the cut was across; provided there was enough work to keep all hands busy. But if an extra man had been provided there would not have been enough for either of them, so it was advisable to let one man do it all, and have him get around as rapidly as possible. The question naturally arises "Why run at such extremely high speed and have to wait at the end of cut?" As much work would have been accomplished had the speed been gaged so that the cut would be completed just before the workman got around; and the tools would have stood up much longer. The bearings on the machine would not have worn out as rapidly, neither would it have taken as much power to run.

The number of feet per minute at which a cutter runs should not be the only thing taken into consideration, but also the speed at which it is necessary to run the cutter—or the stock as the case may be—in order to produce the maximum amount of work possible on a machine, in a given length of time. A shop owning a large number of milling machines considered installing enough more to enable them to increase their product 50 per cent. They were advised, instead, to harden their cutters by a process entirely different from that which they were using, with the result that they were able to speed their machines up and get from their equipment the desired increase in output without the extra expense of *new* equipment. When it is possible to increase the amount of work turned out by a machine by increasing the speed, it should be done, provided, it *will* increase the output of the machine; but if the increased speed necessitates grinding the cutters so often that the output is curtailed rather than increased, then it is folly.

To enable them to run at high speed, some shops harden their tools by methods that insure the desired results. When speeds greater than it is possible to obtain with ordinary carbon steels are desired, it becomes necessary to use the high-speed steels. The various high-speed steels can be procured in almost any form—either in the shape of bars, blocks, or blanks for milling machine cutters. They can be obtained in the annealed state, so they can be machined to shape very readily, or they may be annealed on the premises.

Many times a *high speed* is used to turn out an increased amount of work when the result might have been attained by the use of *coarser feeds*, and the cutters would have retained their edge much longer. It is a mistake oftentimes to feed *too* slowly.

While the matter of increased feeds is being treated there are several things that must be considered. First, the strength of the machine must be taken into consideration; then the strength of the arbor—if the machine be a milling machine; the strength of the cutting portion of the tool, and whether it will be able to resist the additional strain without breaking or springing; the ability of the piece of work or the fixtures holding it to resist the added pressure, etc. A lathe tool if made of light stock or if the cutting portion is too light, will not turn a piece of steel having an irregular surface true if heavy cuts or feeds are used. A milling machine cutter whose teeth are too light cannot be subjected to coarse feeds, for the teeth will spring, dig into the surface of the work, and probably catch and break. A milling machine cutter, or similar tool, whose teeth are too fine cannot be given a coarse feed, as the spaces between the teeth do not furnish sufficient room for the chips; and again, being filled with chips the lubricant cannot get to the teeth, so they will heat and dull very quickly.

The writer recalls an instance of a milling machine cutter of the form shown in Fig. 1 which had 42 teeth. The cutter was 3½ inches in diameter, and was used in milling a handle bar binder for a bicycle. It was not possible to mill more than 20 or 22 of these pieces in a day. A *formed* cutter having only 9 teeth was made and it was found that 120 pieces could be milled per day on the same machine. The difference in results was due to the much heavier feeds it was found possible to use when the cutter teeth were strong and there was sufficient room for the chips and lubricant.

Sometimes a forming cutter for use in a lathe or screw machine is made very light as shown in Fig. 2. To produce a smooth cut it is found necessary to run the machine very slowly, and to support the tool as shown in Fig. 3, possibly even to do both, *i. e.*, to run slowly and support the tool. Now were the tool made sufficiently stiff it would not be necessary to run as slowly and it could be fed much faster.

Reamers and taps are oftentimes made with the teeth or lands so weak that it is found impossible to do a satisfactory amount of work with them. In the case of a tap, the lands when light will spring and consequently open out into the work, unless it is handled very carefully. And the operator is obliged to turn but a very little, then back out a little, and so continue doing until the hole is tapped, which is very slow work, and generally very unsatisfactory. A reamer whose teeth are light is also a source of much annoyance, as only the finest feeds can be used or the teeth spring out, gouging into the work, break the reamer teeth and produce a ragged, uneven hole. It is of course necessary in the case of a tap or reamer to provide sufficient space for the chips, and to give a chance for the lubricant to get at the cutting edges, which can be done by properly designing the tooth.

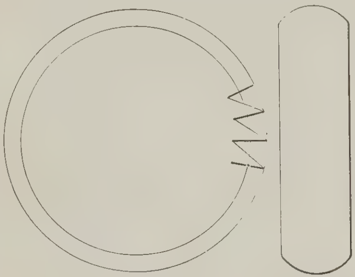


Fig.1

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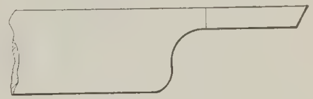


Fig. 2

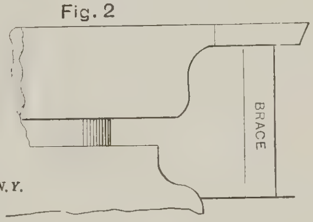


Fig. 3

While the design of the cutting tool has much to do with its success, yet it cannot possibly do the amount of work it should unless properly hardened. If steel is not given the proper heat when hardened it is not in a condition for running at a high rate of speed; and if it is overheated the tool is weak—and if subjected to coarse feeds, the cutting portion will break.

Tools made of carbon tool steel are capable of higher speeds if hardened by the method known as "Pack Hardening;" then again, being much stronger, they are capable of resisting coarser feeds than if hardened by the ordinary methods.

In these days of competition, when speeds and feeds are a matter of vital importance, every phase of the subject must be considered to get the most possible work. It is of course possible to accomplish *something* on a machine that is too light for the purpose, but much more can be accomplished if the machine and tools are adapted to the work in hand. The modern high-speed steels are doing a great deal to revolutionize shop practices, yet much better results can be obtained with carbon steels than is often the case.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

6. R. M. S.—In making a peculiar form of self-oiling, babbitted journal box, we wish to core an oil pocket between the cast iron box and the babbitt shell. Have tried to use a sand core, but without success, owing to the shape of the pocket. Is there anything that can be used for a core in such a place?

A.—For work of this kind a core made of common beeswax will be found to work very satisfactorily. By warming it gently it can be formed into any shape desired. When the babbitt is poured it hardens so quickly that the wax does not have time to melt, so that a perfect core is formed. The wax can then be removed by slowly heating the box and pouring it out as it melts, care being taken not to heat the box hot enough to melt the babbitt.

7. F. R. H.—To run a 20 horse power motor on 220 volt circuit according to the maker's catalog requires 85 amperes. Figuring this by the formula given in Kent's Mechanical Engineers' Pocket Book, $\text{H. P.} = \dfrac{\text{Volts} \times \text{amperes}}{746}$ it should require about 68 amperes. Is the motor rating or the formula at fault?

A.—The formula to which you refer does not take into consideration the efficiency of the motor, which is generally but 75 to 80 per cent. of the result obtained by the formula as given. For practical purposes the formula should read H. P. $= \dfrac{\text{Volts} \times \text{amperes}}{746} \times f$, in which $f =$ the efficiency of the motor. Suiting this to your case and allowing an efficiency of 80 per cent. we have:

$$\text{H. P.} = \frac{220 \times 85}{746} \times .80 = 20, \text{ which agrees with your rating.}$$

8. A. E. H.: Will you please explain what is meant by "Eastern" hose thread, "California" thread and regular hose thread? Please give table of standard of sizes and pitch of threads.

A. We are informed by the Allen Fire Department Supply Co., Providence, R. I., that hose threads, in use by the fire departments of the different cities, all vary more or less, hardly any two in the country being exactly the same. For example: New York has a standard of its own, which is 8 threads to the inch; Providence has one of 7½ threads per inch; while Raleigh, N. C., has 6 threads per inch, 3 5-16 inch outside diameter. Burlington, Vt., has 2½ × 3 threads, and San Francisco and Sacramento, Cal., have 2½ × 7½ threads, but this is not the same as the Providence standard, which has the same number of threads but a different outside diameter. The same discrepancy also applies to the threads used on the smaller sizes of hose, such as garden hose. Thus it is impossible to present a table of hose threads that could be considered in any way as representing any generally adopted "standard."

9. G. C. N.: In cutting a spur gear for a pattern, when it is desired to cut the space wider than the thickness of the cutter, would it be correct, after the cutter has been once through the blank, to turn the blank so as to take the entire amount of extra cut from one side of the space; or should it be turned first forward and then backward and an equal amount of stock cut from each side of the space? The idea being to keep the shape of both sides of the space alike. 2. Does it materially change the shape of the tooth to set over the dividing head one or two holes?

A. The former method, that of removing all of the stock from one side of the space, would be the only practical way to cut the pattern teeth. By taking one-half of the amount of the metal from each side of the space we would obtain exactly the same results but more work would be entailed. The cutters, as made, will cut the correct form of tooth only when their center line is in line with that of the blank and so long as this condition is fulfilled it makes no difference with the shape of the teeth forming the sides of a space, whether stock is taken from one side or both. 2. Setting over the dividing head one or two holes would only turn the blank on its center and would not affect the position of the blank center as regards that of the cutter, consequently the form of the tooth would not be changed otherwise than to be thinner than standard by the amount that the blank was turned.

* * *

DRAWING WORM THREADS.

Regarding the method for drawing a 29-degree thread that was described in answer to question 2 of the "How and Why" department, "Draftsman" writes: While this method is, of course, perfectly correct I have found the method described in Brown & Sharpe's "Treatise on Gearing" to be much more convenient to use. To draw the sides of a 29-degree thread by this method, upon a horizontal line *A A* draw a semicircle with any convenient radius. Then from the point *B*, where the semicircle intersects the line *A A*, draw an arc with a radius equal to one-half that with which the semicircle was drawn and this intersects the semicircle at the point *C*. A line drawn through the points *C* and *B* will make an angle with the line *A A* of 75½ degrees and consequently with the vertical axis *D D* it makes the required angle of 14½ degrees, which is the angle of the side of the worm or "Acme" thread tooth.

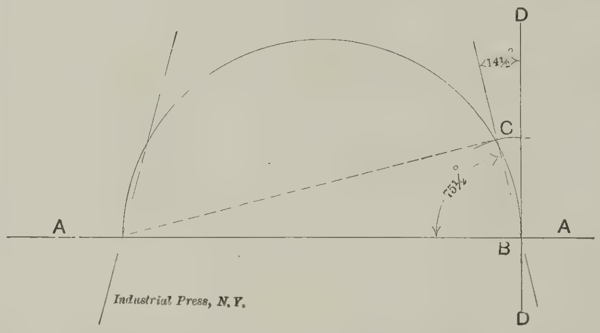


Fig. 1. Laying Out 75 1-2 Degree Angle.

In proof of this method, in the triangle *A B C*, $AB = 4\,CB$, by construction, and the angle *A C B* is a right angle since it is inscribed in a semicircle, consequently the cosine of the angle $ABC = \frac{1}{4} = .2500$. The cosine of $75\frac{1}{2} = .2504$, so that this method is seen to possess the same degree of accuracy as that previously described.

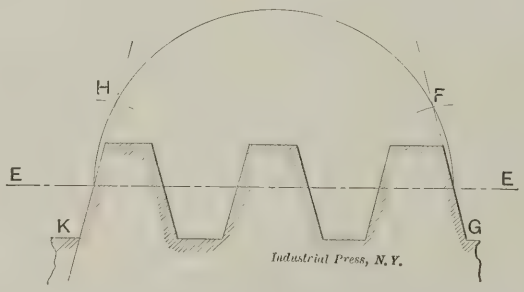


Fig. 2. Application of above Method to laying Out 290 Threads.

In drawing the teeth of a worm or an "Acme" standard thread this method is conveniently applied, as illustrated in Fig. 2. Here the semicircle is drawn on the pitch line *E E* with a diameter equal to the distance from the front of one tooth to the back of another. Then when the lines *F G* and *H K* are drawn, by the above construction, they will form respectively the right- and left-hand faces of the thread teeth. It is then an easy matter to draw the faces of the other teeth from these by the use of the triangle and T-square.

* * *

Errata: According to the present common acceptation of the term in the United States, the expression "diametral pitch" was incorrectly used in the answer to "F. H.," Question 30, August issue. It should be changed to read "diameter pitch."

In the answer to question 33, in the same issue, in the formula by Prof. Carpenter for the flow of steam through pipes, the denominator of the equation should read $7{,}500\ Dd^5$ instead of $7{,}500\ Dd^2$ as there printed.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

STOCKBRIDGE ELECTRICALLY-DRIVEN SHAPER.

We illustrate herewith, in Figs. 1 and 2, a new electrically operated shaper which is the product of the Stockbridge Machine Co., Worcester, Mass. This shaper has a stroke of 24 inches, is back-geared and has a 4 to 1 quick return stroke. The ram is driven by a combination crank motion, which is a new and very powerful mechanical movement and gives an even cutting speed throughout the entire length of the stroke. Especial attention has been paid to the packing for the ram, and the taper packing which has been adopted does away with packing screws and makes it impossible for the ram to get out of alignment. The length of the stroke may be readily changed from the front of the machine and is indicated by an index and pointer so placed as to be in plain view. The head has a travel of 9 inches, and is fitted with a very simple automatic feed operated by an adjustable dog and pawl shown on the side of the machine in Fig. 1. The feeding is done at the end of the return stroke, so that the tool is not dragged back over the scale nor does it require any great amount of clearance to feed in. The length of the feed at each stroke can be readily adjusted to suit the work.

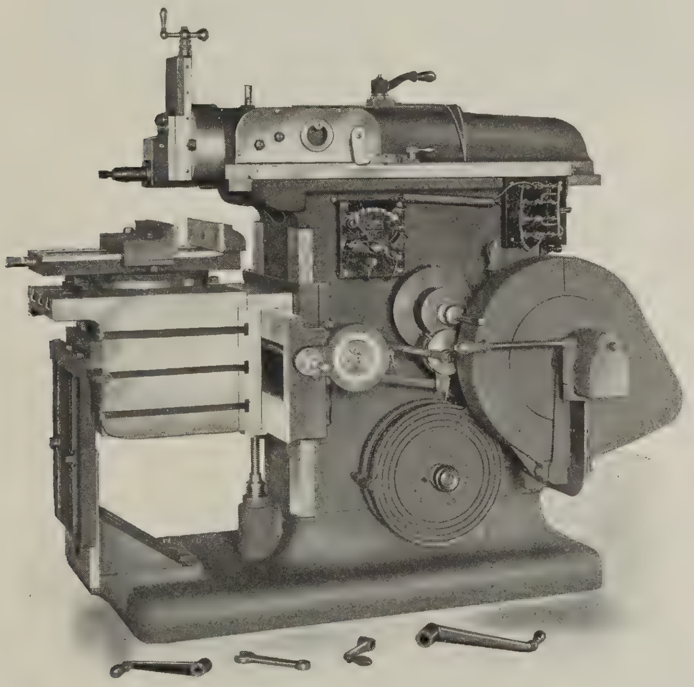


Fig. 1. Stockbridge Shaper with Motor Drive.

The table has a vertical motion of 15 inches and is operated by bevel gears and double screw so that it becomes unnecessary to cut any hole in the floor for the screw to pass through, thus permitting the machine to be set on concrete floors. Ball bearings are employed to facilitate the operation of the elevating screw. The cross-feed is 30 inches in length and automatic in either direction. It is operated through a rod which adjusts itself to any position of the bar, and the screw is fitted with a graduated collar reading to 64ths inch, the same as the down-feed screw.

The machine is operated by a 3 horse power Storey motor, which, by means of rheostat speed controller, may be made to impart a driving speed to the machine varying through a range of 300 per cent. The power is transmitted from the motor to the machine by means of a Morse flexible chain, which provides a quiet and positive driving mechanism that has proved very satisfactory. The shaper is started and stopped while the motor is still running, by means of the clutch lever which is placed at the outer end of the driving shaft. The levers for operating the back gearing, changing length of stroke, feeds, etc., and the switch for starting and stopping the motor, together with the speed controlling mechanism, are all placed where they may be easily reached by the operator without leaving the position ordinarily occupied when running the machine. A circuit breaker, mounted on the back of the column, is shown in the rear view, Fig. 2.

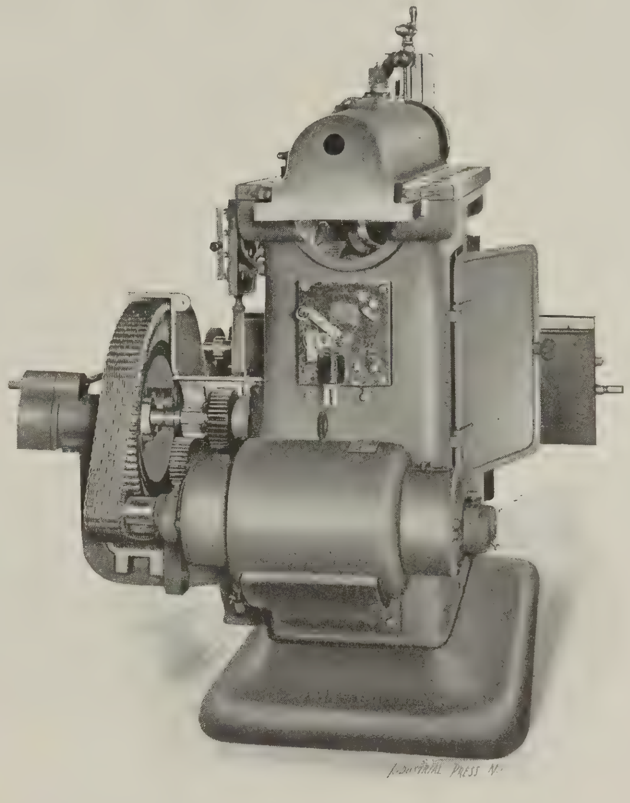
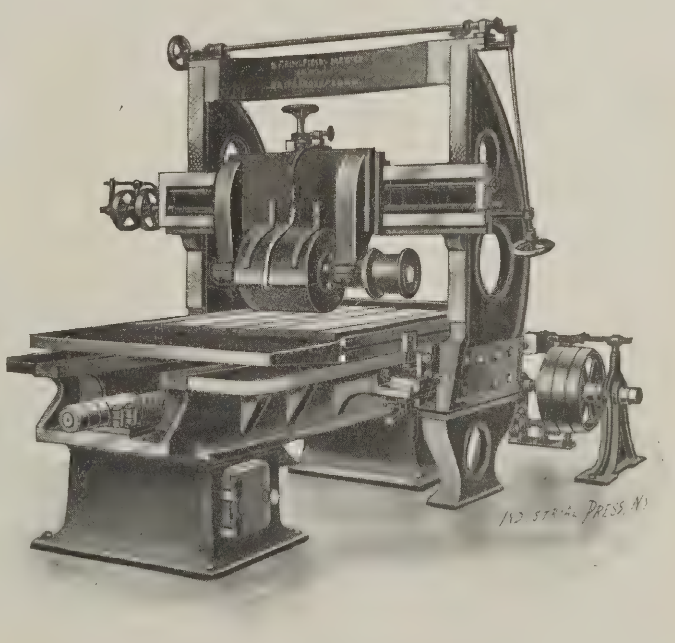


Fig. 2. Rear View of Stockbridge Shaper, showing Motor.

"SPRINGFIELD" SURFACE GRINDER.

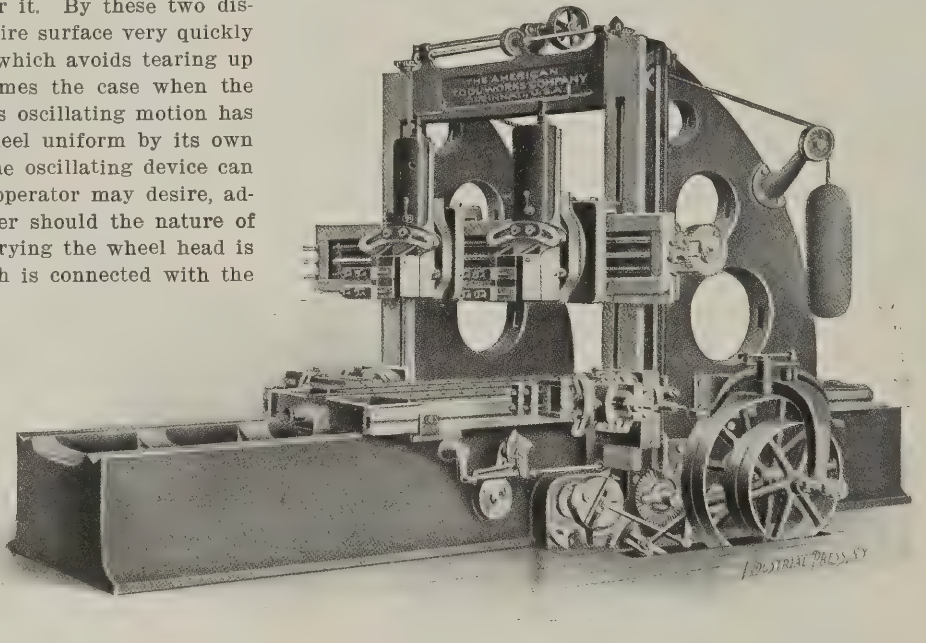
The Springfield Manufacturing Co., Bridgeport, Conn., have added to their line of grinding machines the surface grinding machine that is illustrated in the accompanying half-tone. This will be known as their No. 7 surface grinder. The machine shown in the illustration is designed for surfacing work 5 feet long by 4 feet wide and is adapted for grinding one large surface or several small surfaces at one time. This grinder is especially constructed for the use of water, which is believed by the builders to be a prime factor in rapid and accurate surface grinding. The bed and platen are provided



"Springfield" Automatic Surface Grinder.

with proper aprons to confine the water to the machine, and there are also receptacles in which the water settles before being forced back onto the wheel by the rotary pump. The carriage is operated by a leadscrew, the power being transmitted to the same by a worm and worm gear which has proved very effective in overcoming any chattering.

The emery wheel, which is 16 inches in diameter and has a 16-inch face, oscillates across the platen between the housings while the platen is passing under it. By these two distinct motions the wheel covers the entire surface very quickly and produces the diagonal or file cut which avoids tearing up the fine fibers of metal, as is sometimes the case when the wheel runs parallel to the work. This oscillating motion has also the advantage of keeping the wheel uniform by its own operation. By a simple attachment the oscillating device can be thrown out at any point that the operator may desire, admitting of grinding close to a shoulder should the nature of the work demand. The cross rail carrying the wheel head is easily adjusted by a hand wheel which is connected with the elevating screws by the use of bevel gears. The wheel head has also a micrometer adjustment allowing the wheel to be adjusted to one-quarter of a thousandth of an inch. An idler is provided to automatically adjust the belts on the emery wheel and cross rail. The builders of this machine are prepared to furnish it for any desired capacity, from 2 feet long by 14 inches wide up to 20 feet long by 10 feet wide



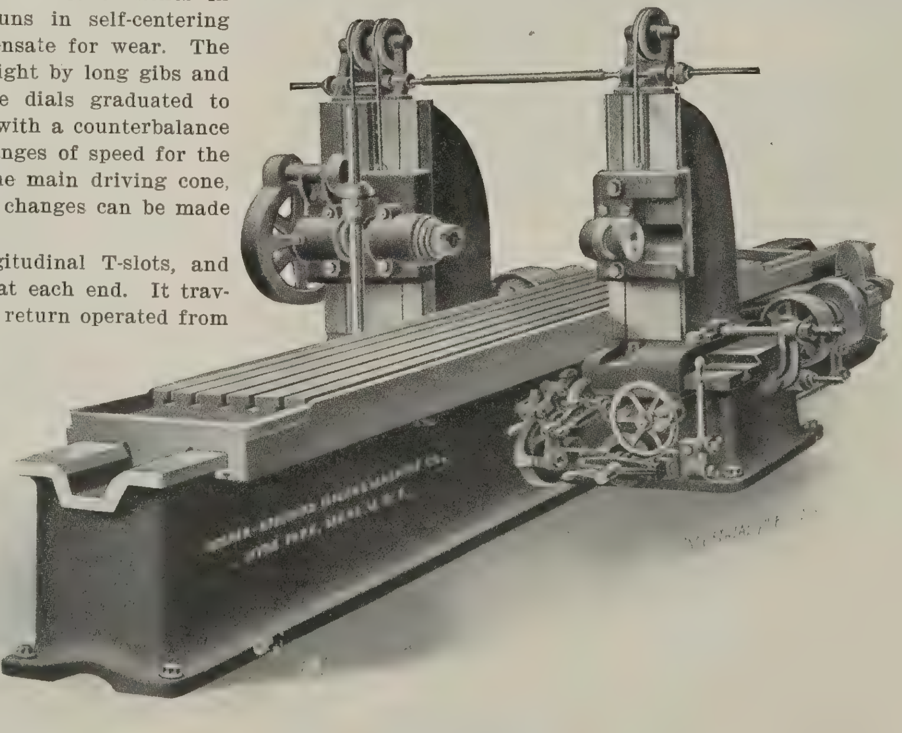
"American" 48-inch Planer.

BECKER-BRAINARD PLANER TYPE MILLING MACHINE.

The Becker-Brainard Milling Machine Co., Hyde Park, Mass., have just added to their line of milling machines the 32-inch x 26-inch x 10-foot planer-type machine that is shown in the accompanying half-tone. This machine is designed for strength, rigidity and power, with special provisions for ease of operation and the demands of modern milling machine practice. The crucible steel spindle, which is 5 inches in diameter, has a threaded nose and runs in self-centering boxes with nut and check nut to compensate for wear. The spindle carrier is held firmly to the upright by long gibs and is elevated by a screw with adjustable dials graduated to thousandths of an inch. It is provided with a counterbalance for ease of operation. There are 20 changes of speed for the cutter spindle obtained by gearing in the main driving cone, operated by clutch and lever so that all changes can be made instantly.

The table is provided with five longitudinal T-slots, and has an oil channel the full length and at each end. It travels on flat gibbed ways, and has a quick return operated from a separate countershaft. It can also be moved by the usual hand wheel. The platen has a working surface of 120 x 26 inches, with a longitudinal feed, automatic in either direction, of 120 inches. The feed of the table is operated through gearing from the spindle by means of a belt running on a five-step cone and giving a range of feed, through eight changes, from 3-64 to ⅜ inch. The changes of feed can be effected instantly by a lever, without stopping the machine.

The head may be adjusted in either direction from either side of the machine so that it is not necessary to take the cutters off from the arbor in order to change their position in relation to the work. The greatest distance from the center of the spindle to the table is 28 inches and the least is 2 inches. The bed is of extra depth, extending to the floor and making a solid foundation. It can be made of any length desired. The weight of the machine, with the 10-foot bed, is about 25,000 pounds.



Becker-Brainard Type Milling Machine.

NEW "AMERICAN" PLANERS.

The American Tool Works Co., Cincinnati, Ohio, have thoroughly redesigned their entire line of planers, from 22 to 48-inch sizes, with the purpose of adapting them to the increased duties imposed by modern shop practice. Every condition influencing modern planer work has been given careful consideration with a view to increasing the efficiency of the machines and adapting them to the use of high-speed steels. Strength and rigidity being the foremost aims, the bed has accordingly been made very heavy and of unusual length in proportion to the table, so that there will be but a slight overhang of the table when planing to full length.

The table has a new shifting mechanism which reverses the belt from one pulley before the return belt engages the other, thus obviating any disagreeable shrieking of the belts. A safety locking device prevents the table from starting before the operator is ready, while it may be easily run from under the tool for an examination of the work. The housings are of the double-webbed cored-section type, with wide bearings for the cross rail which is raised and lowered rapidly by power. The heads on the rail are made right and left to permit them to work close together, and the saddles are graduated for angular planing.

The feeds are all automatic and can be operated from either side of the machine. The down feed is of exceptional length and equipped with micrometer adjustment. The side heads are of the compound slide type, are counterbalanced and can be run below the level of the table when not in use. Each shaft is so arranged that it can be readily removed, when necessary, without disturbing the rest of the machine, and all of the gearing is located on the inside of the bed.

THE MOTOR-DRIVE AS APPLIED TO MILLING MACHINES.

Figs. 1 and 2 illustrate one of the latest steps in the adaptation of the electric motor to the purpose of machine tool operation. These milling machines, made respectively by the Brown & Sharpe Mfg. Co. and the Cincinnati Milling Machine Co., are operated by Crocker-Wheeler shunt-wound motors. The regulation of speed is obtained by the use of a Crocker-Wheeler, 12-point controller, designed to operate on a 4-wire multiple voltage system of current supply, and gives six speeds by voltages ranging from 40 to 240, by steps of 40 volts each. An equal number of intermediate speeds is secured by the use of resistance, giving in all 12 speeds in either direction.

The motor is located directly over the machine, where it is enabled to drive the spindle at a point between the bearings, and at the same time it in no way increases the amount of floor space occupied. Power is transmitted from the motor to the spindle of the machine by a Morse rocker-joint chain which is much more satisfactory than a belt, owing to the extremely short distance between the centers of the shafts. In its operation the chain is positive and noiseless, and the pull exerted between the motor shaft and the spindle is only that necessary to transmit the power required. The sprockets and the chain are entirely encased in light guards which are easily removed when necessary, but which normally protect the chain from dirt and the workman from injury.

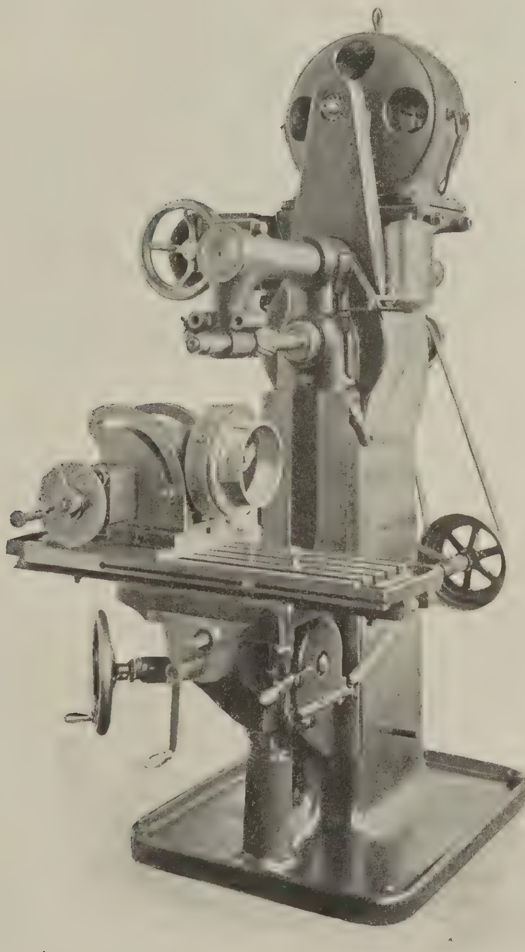


Fig. 1. Brown & Sharpe Milling Machine with Motor Drive.

The Brown & Sharpe machine, being designed for light work, is fitted with a 3 horse power motor, which is connected to the spindle of the machine by a speed reduction of about 3½ to 1. The highest speed of the motor drives the spindle at 276 revolutions per minute, and the slowest speed at 44. The height of the machine and motor over all is but 6 feet 4 inches, so that the motor is readily accessible for adjustment or examination.

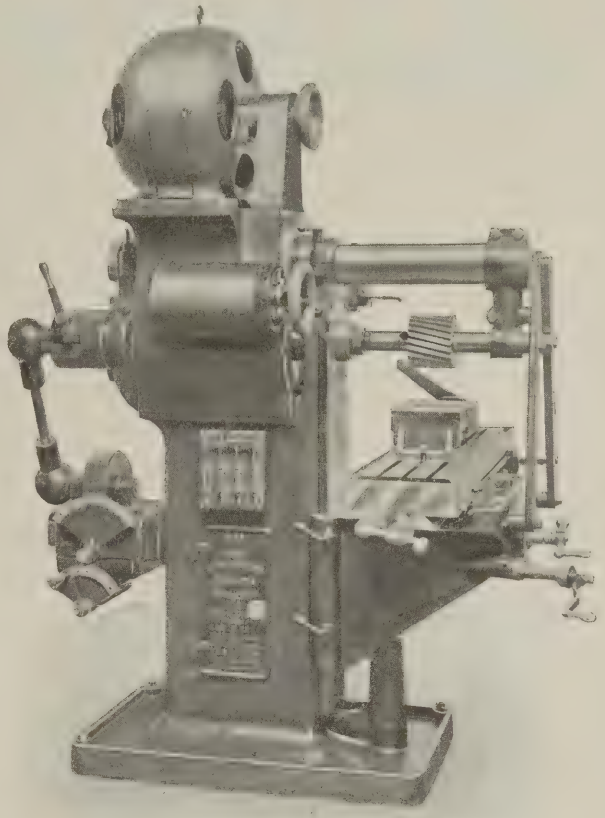


Fig. 2. Cincinnati Milling Machine with Motor Drive.

The Cincinnati machine is built for rather heavy service, and is fitted with a 7½ horse power motor. This machine is provided with a powerful feed changing mechanism, covering an exceptionally wide range. Sixteen feeds are available, and they may be changed instantly from one to another without stopping the machine and regardless of the speed of the spindle. Beside the 12 different speeds secured by the motor, 24 more may be obtained by the use of back gear combinations. The greatest available speed of the spindle is 278, and the least 14 revolutions per minute. The hand wheel, shown on the extension of the motor shaft, is for turning the motor by hand when the power is shut off, so as to permit the teeth to intermesh when changing the back gear combinations. All gears, chain, or other dangerous moving parts are carefully inclosed and every precaution has been taken for the protection of the operator against accident.

NEW CLAMPING DEVICE FOR MICROMETER CALIPERS.

The Brown & Sharpe Mfg. Co., Providence, R. I., have recently placed upon the market an improved device for clamping the spindle of micrometer calipers, which is very simple and efficient, a slight movement of a knurled nut being all that is required for clamping the measuring spindle firmly. After a measurement has been taken it is often desirable to lock the spindle to retain the measurement, and it is important that the spindle should not be rotated or moved longitudinally in order that the original measurement be not altered. The construction of this device is such that the possibility of disturbing the adjustment is entirely avoided. Its general appearance, as applied to the calipers, is shown in Fig. 1, on next page, while the details of its construction are clearly illustrated by the drawings in Figs. 2 to 5, the operation of the mechanism being as follows: The split ring, *B*, Fig. 2, fits the measuring spindle with a sliding fit when open, thus insuring a longer bearing for the spindle than has been possible with the devices heretofore used for this purpose. The ring is held firmly from rotating by the lug, *D*, which fits into a recess in the slot, *K*, Fig. 5. The roller, *C*, Fig. 2, which moves upon the inclined surface cut in the periphery of the ring, is actuated by the ring, *A*, Fig. 3. The clamping ring, with the roller at the lowest point, fits into the ring, *A*, with a sliding fit; and as the clamping ring is held from rotating, the movement of the actuating ring, *A*, to the right forces the roller up the inclined surface, *E*, and closes the ring concentrically around the measuring spindle. The slot in the caliper frame, Fig. 5, receives the two rings together with the roller, and the spindle is passed through the clamping ring. It will be seen that as the clamping ring closes concentrically there is no opportunity for dirt or grit to get into the device, and spindle cannot be thrown out of alignment when clamping. The clamping ring cannot be taken out of the frame until the spindle has been run out sufficiently to clear the recess, and this prevents the device from being accidentally lost, as is many times the case with a nut and split bushing that fits over the end of the spindle.

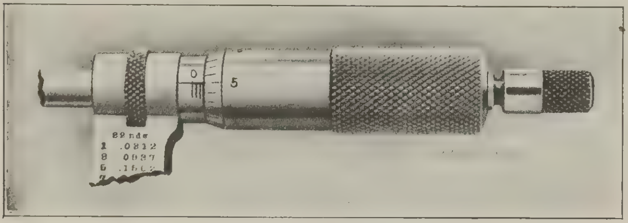


Fig. 1. Clamping Device for Micrometer Calipers.

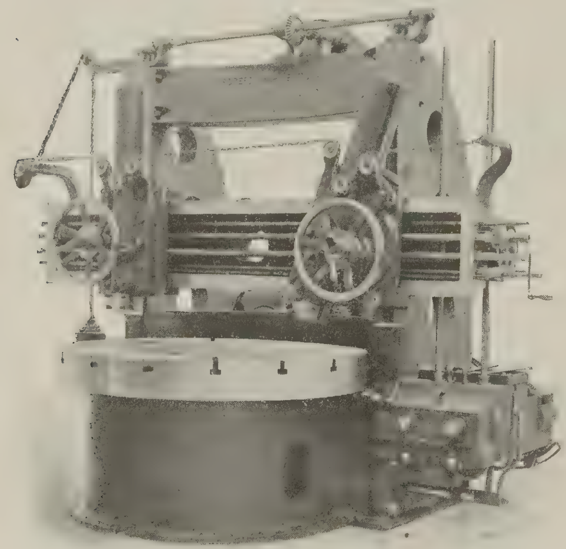
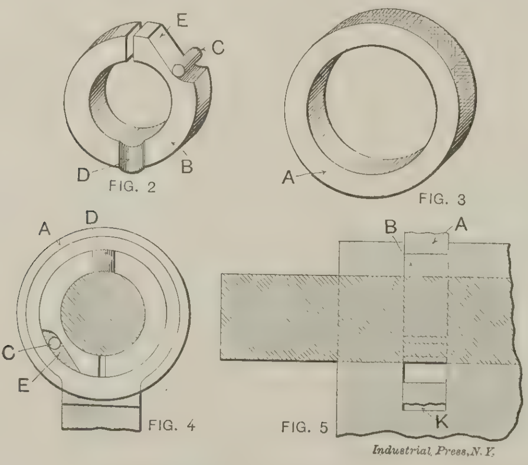


Fig. 1. Rogers Boring Mill—Front View.



Details of Micrometer Clamp.

Another new feature of this device is that the tension of the measuring spindle can be adjusted without disturbing the threaded portion of the screw and nut. This is a valuable feature when measuring a number of pieces for comparison, as sufficient tension can be put on the spindle to prevent its turning when the work is passed between the measuring points and at the same time the spindle can be left sufficiently free to allow of slight adjustments. When the clamping ring has been set to exert a certain tension, the rotation of the spindle cannot alter it, for the reason that the clamping ring is held stationary and forms part of the bearing of the spindle.

ROGERS BORING AND TURNING MILL.

The accompanying photographs, Figs. 1 and 2, show the front and rear view of a 62-inch boring and turning mill built by the Rogers Machine Tool Co., Alfred, N. Y., who have entirely redesigned their line of these machines in order to meet the demands of modern boring mill practice and qualify them for the use of high-speed steel. An important feature of this machine is the fact that it can be changed from belt to motor drive at a very small expense, as the driving arrangement is composed of a cluster of gears that are so proportioned as to give a great range of speed and large number of speed changes. The change is accomplished by replacing the driving pulley with a gear, which is shown in the rear view, Fig. 2. In this case the motor is mounted on a bracket securely fastened to the frame.

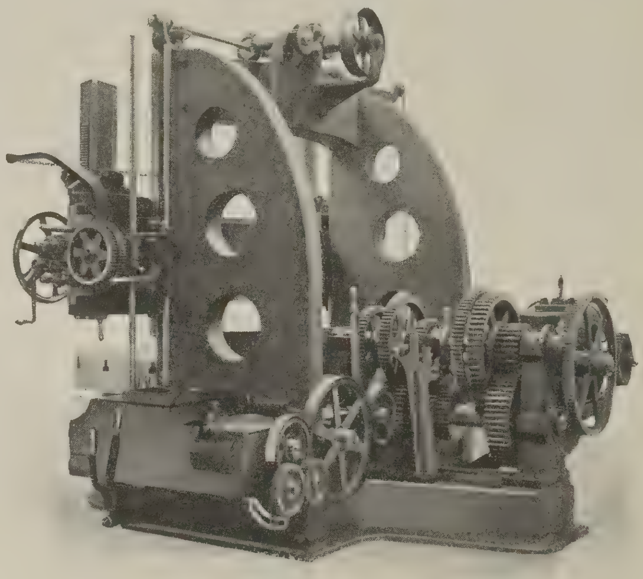


Fig. 2. Rogers Boring Mill—Rear View.

The table is supported by a spindle with V-shaped bearings of large diameter, and the foot brake, which is one of the features that have been retained from the earlier machines, enables the operator to stop the table in any desired position. The cross rail has a belt lift so arranged that only the pulley shaft need be run when raising or lowering the rail. Positive gear feeds are used, which are operated by levers, and each head is independent in amount and direction of feed. The feeds are easily operated, the levers being convenient to the operator's hand. The machine can, at any time, be fitted with screw cutting or drum grooving attachment.

THE "CHICAGO" ADJUSTABLE BORING TOOL HOLDER.

The "Chicago" adjustable boring tool holder has been designed to meet the demand for a holder for use with self-hardening tool steels, and one that shall be quickly adjustable to the different sizes of lathes upon which it may be used. In using this holder the tool post is removed from the lathe and the holder clamped to the cross slide. This provides, in reality, two tool posts five inches apart which furnish a very rigid support for the boring bar. The bar itself is secured in the holder by two clamps, operated by setscrews, and the cutter can be swung to any desired height at which it is clamped by a setscrew on the side of the holder. The form of clamp used for holding the bar, together with the provision for adjusting the height of the cutter, permit the use of any size of bar within the limits of the holder.

MACHINERY.

November, 1903.

MACHINE SHOP EQUIPMENT.—3.

PLANS FOR THE DRAWING ROOM AND ITS EQUIPMENT.

OSCAR E. PERRIGO.

Brains are more important than hands; ideas are more sought after than things; the conception of that which we are to do, of that which we are to develop or to build, to produce and to sell, are first in the natural order of conducting all manufacturing operations, or of entering into any line of the world's trade and commerce. The *plan* is the first and important matter, and to plan well and wisely we must have the best ideas obtainable. These ideas and conceptions have many and far-reaching results and consequences, both as to a matter of mechanical and of financial success. Good ideas, properly developed and elaborated, may mean the beginning of years of business success to the owners or the promoters of the enterprise; while defective and ill-considered plans may mean practical ruin or thousands of dollars wasted in fruitless work.

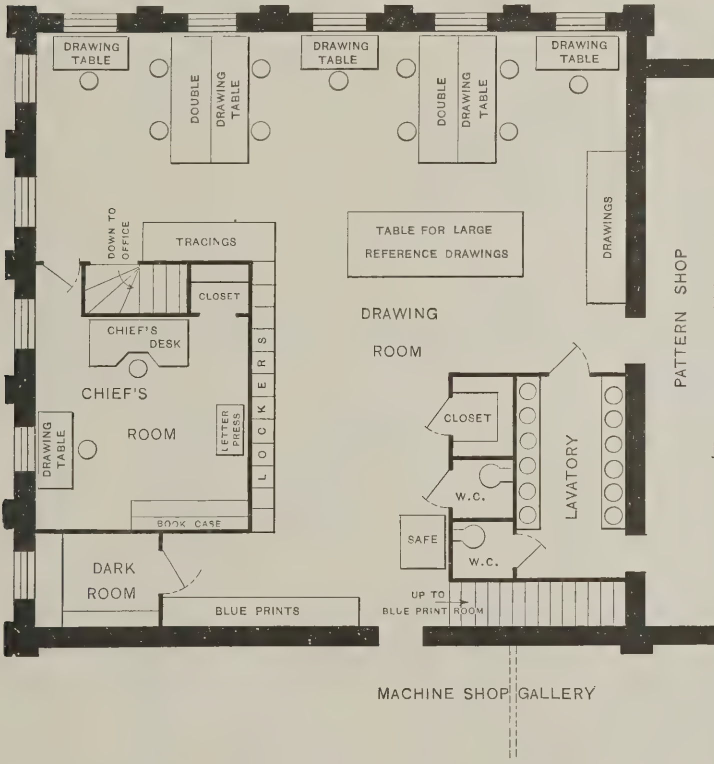
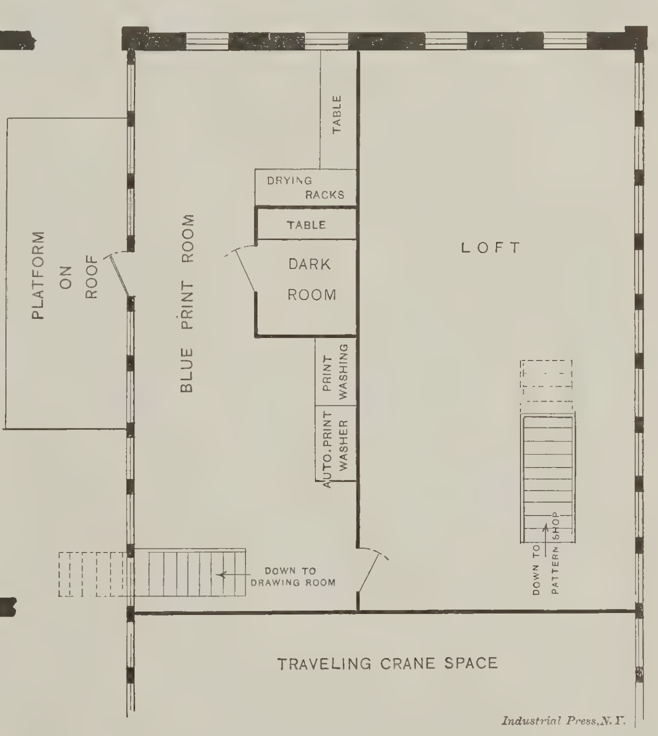


Fig. 1. Drawing Room and its Arrangement.



Industrial Press, N. Y.

Fig. 2. Blueprint Room.

But to plan well, to bring out the best ideas of the men whose duty in life is to study and think and plan the work that others are to perform, men should be placed in proper and congenial surroundings, which may inspire them to conceive and bring out the very best ideas of which they are capable, just as in any other line of human effort we make the conditions as favorable to success as we can if we are to expect good results.

The drawing room of the machine shop has often been facetiously called "the brain room," by those who have little conception of its real usefulness in the manufacturing establishment. Yet this is precisely what it should be, if it is properly organized, equipped, and has the right quality of men in its working force. And nowhere in the whole establishment is there more need of men of original thought; of men with ability to "see the point," to grasp the situation and make practical use of ideas and suggestions as they present themselves; and to take apparently worthless plans or devices and develop them into that which is mechanically good and financially profitable. These conditions making the drawing department one of the most important in the whole establishment, it naturally follows that in its location and equipment much thought and care should be exercised so that all the conditions and surroundings should be of the best, as to their kind and their adaptation to the particular class of product which the establishment is to turn out. By this we do not mean that the drawing room should be expensively or luxuriously fitted up. Its design may be comparatively plain and yet architecturally and artistically correct and agreeable. Its furniture may be simple and yet appropriate, and serve its purpose as well as that costing several times as much. Dark-colored woods should not be used owing to the fact that their color absorbs so much light. We should choose, rather, light-colored woods such as oak, ash, birch, or even white pine varnished, according to the amount available for the work. The walls may be wainscoted or sheathed up to about the height of the tables, but above this line they should be finished with a plain, white surface. The ceilings should also be white. A hard finish of what the plasterers call "adamant" is very durable and may be rendered still more so by painting with oil paint, several coats of which should be put on, in preference to kalsomining.

The windows should extend from the height of the drawing tables entirely to the ceiling. They should be provided with two curtains, one reaching from the top of the window down to the center, and a second one reaching from the center down to the bottom. The men working directly in front of the windows should only handle the lower curtain; and those in the center of the room have charge of the upper curtain. The curtains should be white, or nearly so. Instead of curtains some prefer ribbed glass, as it does not admit a glaring light in any one place, but is very useful in diffusing the light over the whole room, and the appearance of the room is much better than where curtains are used. Some prefer plain glass for the lower portion of the window and ribbed glass for the upper portion.

Electricity is the favorite artificial light, and the incandescent lamp seems to be the proper one. The question of whether we shall use enough of these, placed high up, to flood the whole room with light, or have them low down and under the control of each individual, is still discussed with fairly good reasons on both sides. Probably a majority of draftsmen will prefer the individual lamps which they can place in any position best calculated to aid them in the particular kind of work in hand.

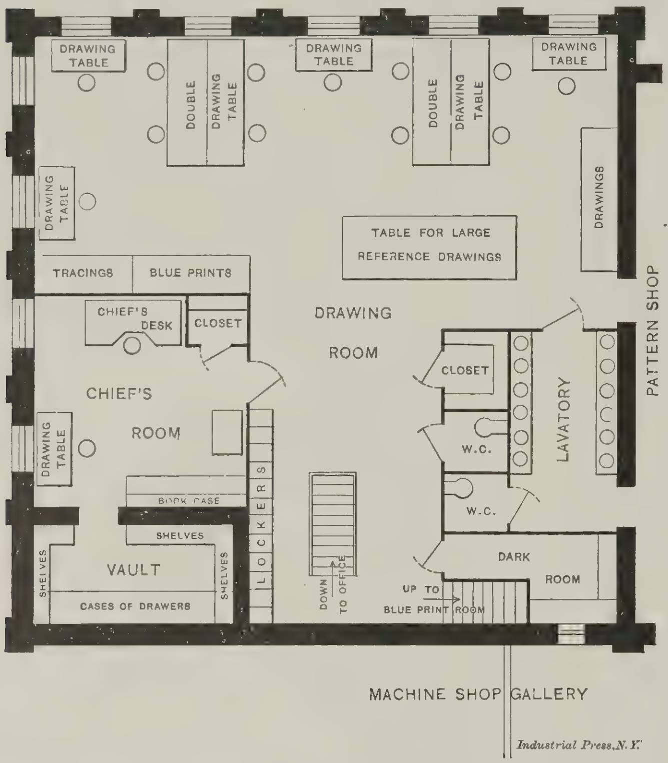


Fig. 3. Drawing Room Arranged for Storage Vault in one corner.

Some of the more important conditions in reference to the location and construction of the drawing room are these: It should be away from the noise and bustle of the machine shop, yet near enough to make the latter readily accessible. It should be directly connected with the pattern shop as it is so intimately associated with it in many of the preliminary operations. It should be readily accessible from the offices. It should have plenty of fresh air and be well ventilated at all seasons of the year. In winter the heating system should be such as to maintain as even a temperature as possible. It should be well lighted, by natural light by day, and a proper artificial light during the hours which make it necessary. It should be provided with proper facilities for photographing machines, or any of the articles produced by the shops. It should have connected with it, but not installed in it, facilities for blueprinting, where an abundance of light is available at all hours of the day. It should be provided with proper facilities, not only for making drawings and tracings, but for indexing them, for issuing and receiving them, and for safely preserving them from fire or other injury. In the descriptive matter which follows and the drawings illustrating it, the effort has been made to meet all of these conditions in a practical and economical manner, and on such a plan as will provide drawings, tracings, blueprints, etc., for small or large plants, or for a large variety in the product to be manufactured; as will be pointed out in detail later on in this article.

In the drawings, Fig. 1, is a plan of the drawing room, located above the offices and well lighted by ten large windows, as shown. It is reached from the latter by a broad flight of stairs. Along the front are located the drawing tables, providing for eleven draftsmen. The arrangement is so made that three of the single or regular tables are for the draftsmen making the general drawings, their tables facing the windows. Between them the two double tables are placed, with their ends toward the windows. These tables accommodate four men each, who do the detail work and the tracings. The circles in front of the tables indicate the positions of the men.

The single drawing tables are shown in perspective in Fig. 5. These are of the plainest construction consistent with usefulness. The top inclines one inch to the foot, and is three by six feet, which is ample for most general drawing work. They may be made with vertical legs, but the crossed legs here shown are more rigid. Braces extend from the crossing of the legs to the center beneath the drawers, to support the top as well as to act as braces to insure stiffness. Foot rests are provided, ten inches from the floor. The height of the tables in front is thirty-seven inches. Three drawers are supplied for holding instruments, books, memoranda, etc.

Many more or less complicated forms of drawing tables as well as other equipments for the drawing room, have been devised, described, illustrated, built, used, and in many cases discarded; and it has come to be the opinion of many of the older draftsmen that while each of the more complicated devices has its peculiar merits, the simpler forms are, in the long run, best adapted for every-day work. The double drawing tables are shown in Fig. 6. They are six feet by ten, and are the same height and inclination of top as the single tables. Three drawers are provided for each draftsman, and a convenient shelf is placed over the center, within the reach of all the men, for holding instruments and many small articles that it is desired to place out of hand but within reach. Foot rests are provided the same as in the single tables. These tables are of the proper height to permit the draftsmen either to sit or stand at their work, as a change of position is much easier than maintaining either one of these positions for hours at a time.

The chief draftsman has a separate room and he is provided with one draftsman whose duty will be that of working out special devices that come more particularly under the constant supervision of the chief. The desk of the chief is shown in Fig. 7, and is identical with one used several years by the writer and found to be a very useful and practical desk and drawing table combined. The top is thirty inches

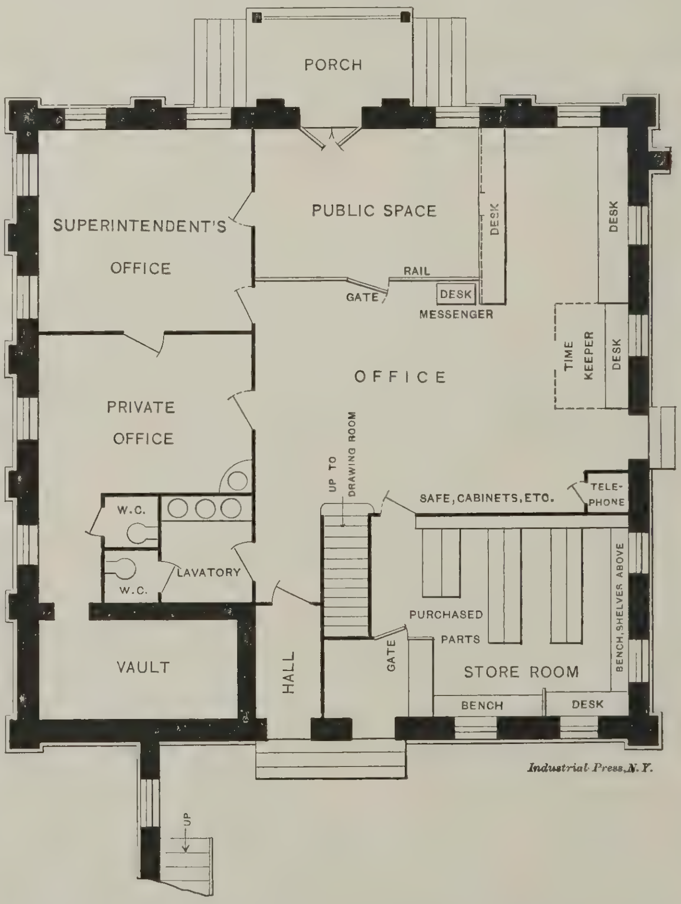


Fig. 4. Arrangement of Offices under Drawing Room, when there is a Vault.

high, and thirty-four inches wide by six feet long. The center of the top at the front is cut out in a semicircular or hexagonal form of a recess to enable the draftsman to sit in close to his work and at the same time to have ample table room at the right and left. Two boards drawing out under the top, one at each side, add to this space, so that a practically continuous table on three sides of the draftsman is provided. This arrangement is very useful where many reference drawings, books or catalogues are to be consulted. Four drawers on each side and one directly in front furnish ample filing space. A shelf at the back is convenient for books or for supporting instruments or other small articles not in use at the moment. The chief's room is provided with a convenient closet, and it has a table with drawers beneath and a bookcase above, as well as a letter-copying press for making letter-press copies of sketches, memoranda and similar matter sent into the shop or to those outside of it. The drawing table used by the chief's assistant is the same as the single tables in the large room.

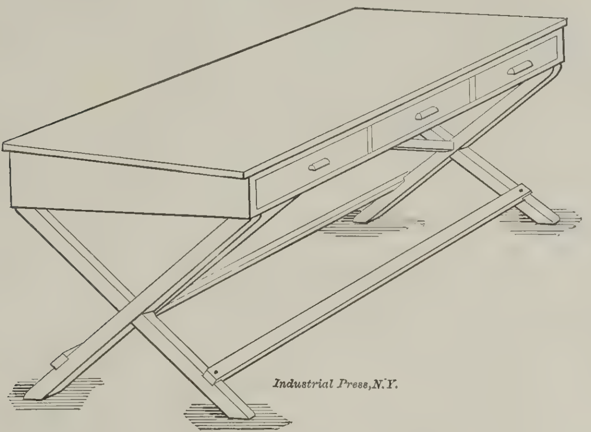


Fig. 5. Drawing Table for one Draftsman.

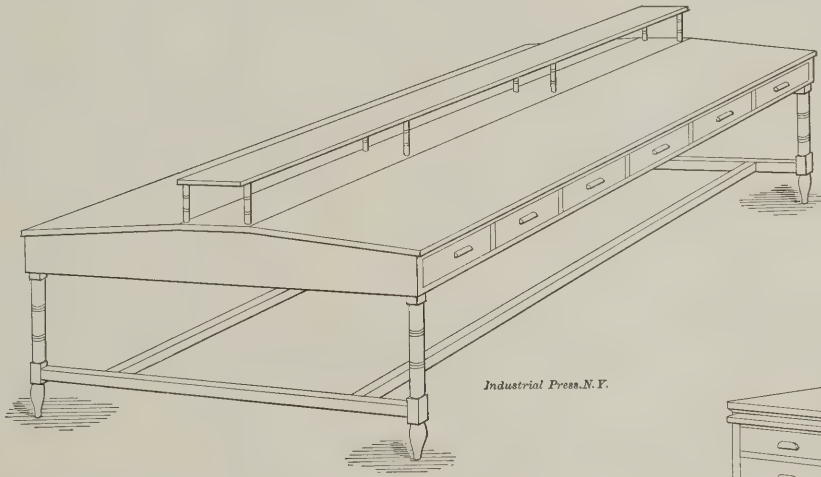


Fig. 6. Double Drawing Table for Detail Draftsmen.

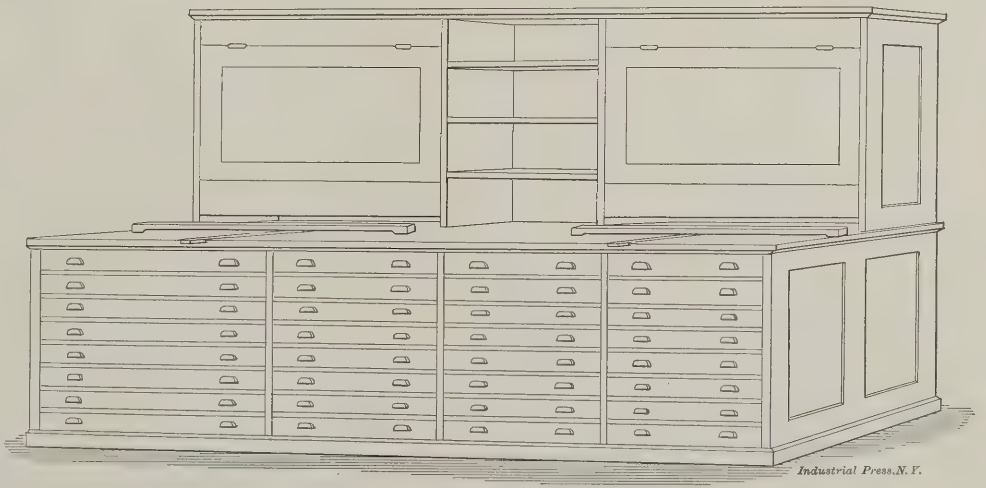


Fig. 8. Case for Filing Drawings and Tracings.

In Fig. 8 is shown a very convenient filing case for drawings. It has drawers for general drawings and detail drawings, made of different sizes to suit their dimensions. These drawers should have a fixed horizontal strip, say ⅜ inch thick and 5 inches wide, running along the back of the drawer at the top, to prevent drawings from curling up and sliding over the back edge of the drawer. In the front part of the drawer a similar strip, pivoted, or hinged so as to turn down over the front edge of the drawings, or back out of the way when the drawings are to be examined, removed or replaced, will be found very useful. In the center of the front each drawer should have a metal label holder, in which a lettered card, readily removed and changed when necessary, describes the contents of the drawer. Usually each drawer is devoted to the drawings of one machine. Above the table are two cases in which are to be kept rolls of drawing paper of different widths or qualities, tracing cloth, tracing paper, etc. Doors hinged at the top and provided with spring catches at the bottom, afford convenient access. The ends of the rolls of paper are brought down at the back and out the front under a guide bar, as shown, and along a sliding scale-of-inches, let into the top covering the drawers, and by which any length or width of sheets are measured, and may be cut off with a knife guided by the guide bar. So far as we know, this is the most practical and convenient method of keeping and cutting up drawing papers; and the plan of purchasing drawing paper in rolls and cutting it up into any desired size of sheets seems to be preferable to purchasing the paper in sheets of odd sizes and trimming it to the dimensions required. In the center, between the two drawing paper cases, are shelves for holding books, catalogues, etc. This case is located against the wall dividing the drawing room from the pattern shop, and convenient of access for the draftsmen.

At the opposite side of the room, and against the stationary partition, is the case for filing tracings; and against the wall next to the machine shop a similar case is used for finished blueprints. It is of the form shown in Fig. 9, and has drawers constructed in the same manner as those in the case for drawings shown in Fig. 8. It is built higher than the latter to increase its capacity, although, of course, it may contain any number of drawings required for the work.

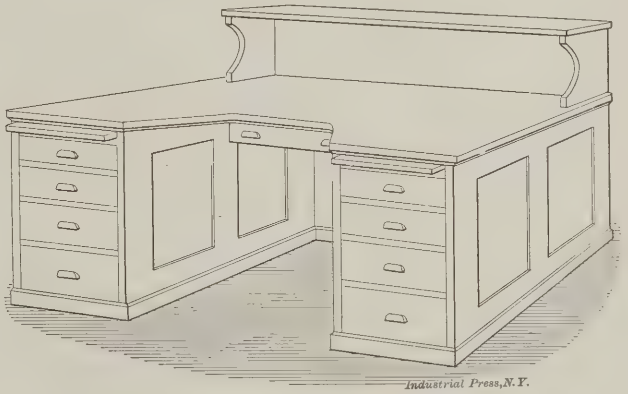
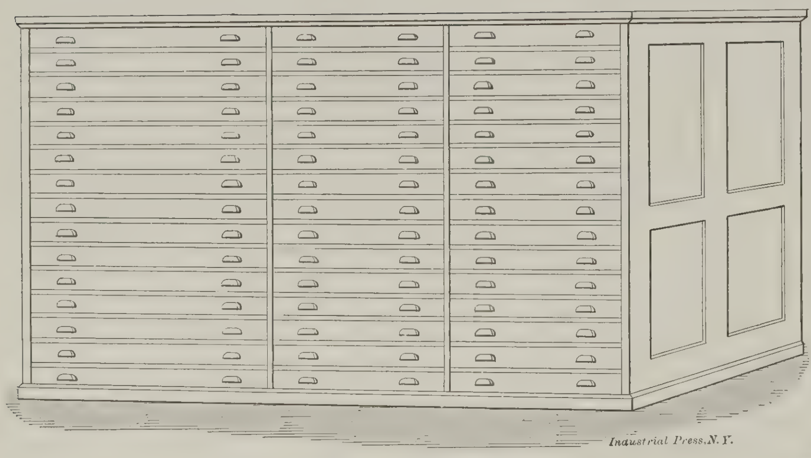


Fig. 7. Chief Draftsman's Desk.

Many systems for filing and preserving drawings, tracings and blueprints have been devised, but here again, simplicity will be found best in practice, and by devoting one drawer to each machine and properly indexing the drawings and tracings, the desired sheet may be quickly found, taken out and replaced, with little disturbance to the others. Where the variety of the work makes it necessary to have a great num-



Industrial Press, N.Y.

Fig. 9. Case for Filing Blueprints.

ber of classes it will be found that a more elaborate system is needed, but the plan proposed will be sufficient for a large majority of establishments. In filing tracings it is well to lay in a sheet of thin straw board between every ten or twelve tracings, or to divide the tracings of a machine into divisions representing the groups of parts of the machine, as, for instance, of a lathe, the headstock, tailstock, carriage, apron, etc. This helps to keep the tracings lying flat without wrinkles and aids in quickly finding the one needed.

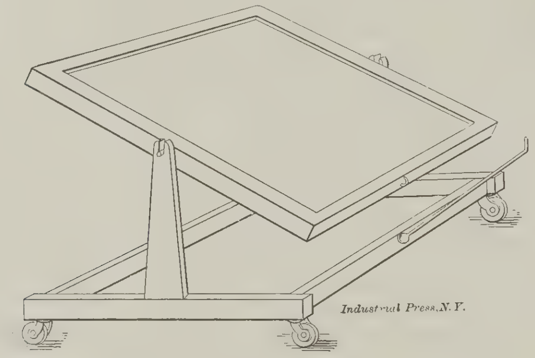


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Fig. 10. Large Blueprint Frame.

Next to the chief's room a dark room is provided for photographic work, as every modern drawing room is expected to be able to make photographs of machinery and similar articles; and this branch of work should not be done in connection with blueprinting, owing to failures that may result from carelessness in handling the necessary chemicals.

In the opposite corner of the drawing room and next to the pattern shop is arranged a lavatory provided with twelve bowls for the use of the draftsmen and patternmakers. In connection with this are two water closets, one of which opens out of the lavatory and is used by the patternmakers; the other opening from the drawing room is for the draftsmen's use. A large storage closet is included in the space devoted to the above purposes and between this space and the rear wall is the stairway leading to the blueprint room above. A fire-proof safe of sufficient size should be provided for storing such records and original drawings of special devices as cannot be readily replaced, and such valuable papers as always accumulate in the drawing room.

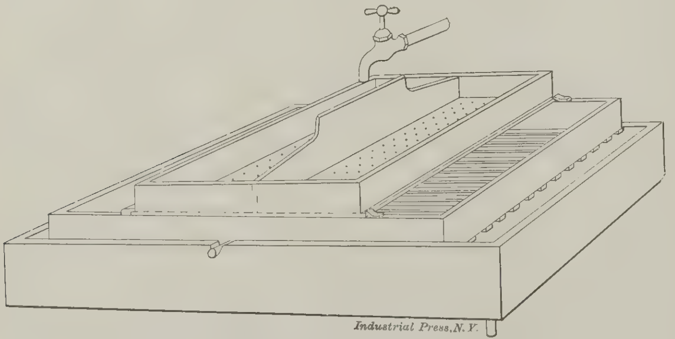

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Fig. 13. Automatic Washer for Blueprints.

In the central space of the room is a table five feet by fourteen, for large reference drawings and similar purposes. Drawers under this table are convenient for holding large construction sheets which cannot be filed in the regular cases without folding.

Against the partition of the chief's room is a row of lockers, one for each man. These should never be constructed of boards, or in any way tightly enclosed, but, as a matter of fire protection and sanitary cleanliness, should be open to a free circulation of air; and nothing which we have seen fulfills the conditions better, or perhaps as well, as what is generally known as the "expanded metal" used in many establishments for this purpose.

The above arrangement of the drawing room and its equipment is intended for cases where there does not seem to be the need of an expensive vault in which to store drawings, tracings, blueprints, etc. Still the want of this means of safety to such valuable records in case of fire has of late years been gaining in importance and would seem, in most cases perhaps, a good investment from the point of view of insurance. Hence an arrangement of the plans of both offices and drawing room has been made with this end in view, and is shown in Figs. 3 and 4. As a matter of economy the vault is built in a corner of the structure, the walls of which form two of its sides. For this purpose the superintendent's public and private offices are placed next to each other and the lavatory located between the latter and the vault, while the stairway leading to the drawing room is placed between the hall and the "Purchased Parts" store room. This permits the vault in the drawing room to be built directly over the one in the offices and next to the chief's room, out of which it opens, without disarranging the plans to any considerable extent. The dark room is placed under the stairs leading to the blueprint room. The vault is provided with cases of drawers similar to those in the drawing room, and with racks for holding negatives, as well as shelves upon which may be stored any valuable records, memoranda and similar articles. These vaults are eight feet wide and sixteen feet long, and have masonry floors and brick arches overhead. The walls should be sixteen inches thick, exclusive of an air space of 1½ inches in the center of the walls. Steel should not be used in their construction unless it is completely covered by brick work, on account of its tendency to warp from the excessive heat of a fire. Double fire-proof doors should be provided,

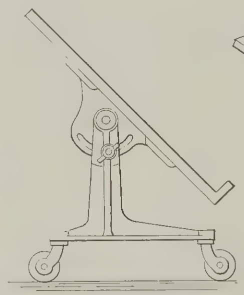

Fig. 11.

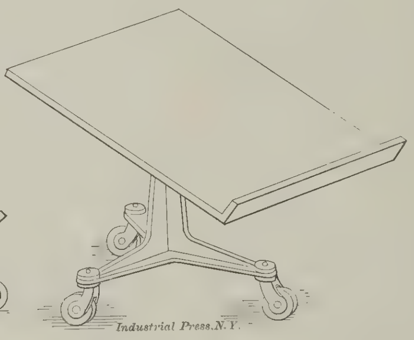

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Fig. 12. Stand for Supporting Blueprint Frame.

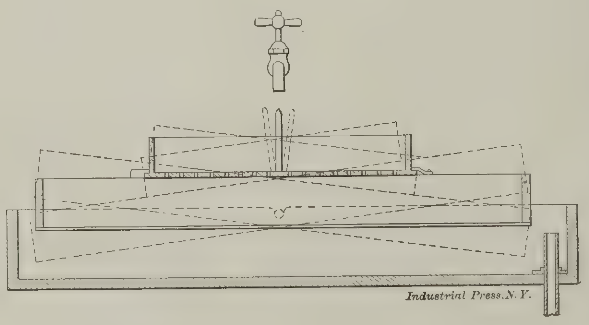

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Fig. 14. Cross Section of Automatic Washers.

similar to those used in safes. The hinges should be held by bolts passing entirely through the walls, as should also be the case with bolts securing the door frames.

The blueprint room is located in the monitor roof in the center of the building, and thus over both the drawing room and the pattern shop. The space available is eighteen feet wide. It is well lighted along one side and across the front end. In it are built a large dark room and other facilities and appliances for print washing and drying, as is shown in Fig. 2. The blueprint frames are opened and filled in the dark room and the smaller ones carried out the door to a platform built over the roof and on a level with the floor of the blueprint room. Instead of being supported by any kind of a rack, they are placed upon an adjustable blueprinting stand, as shown in Figs. 11 and 12. This may be easily turned to face the sun and the supporting board adjusted to whatever altitude the sun may happen to be at the time. The stand is made with a cast-iron standard rising from the base which is supported on three caster wheels of not less than three inches in diameter. A cast-iron support is pivoted between jaws formed in the standard, to which it is clamped in any desired position by a bolt and hand nut, as shown in Fig. 11. The board is attached to this support. When in the room the board may be brought to a nearly vertical position, thereby occupying less space. These stands may be kept in the room and the boards placed upon them and rolled out on the platform, if heavy printing frames are used, but this is not usually necessary.

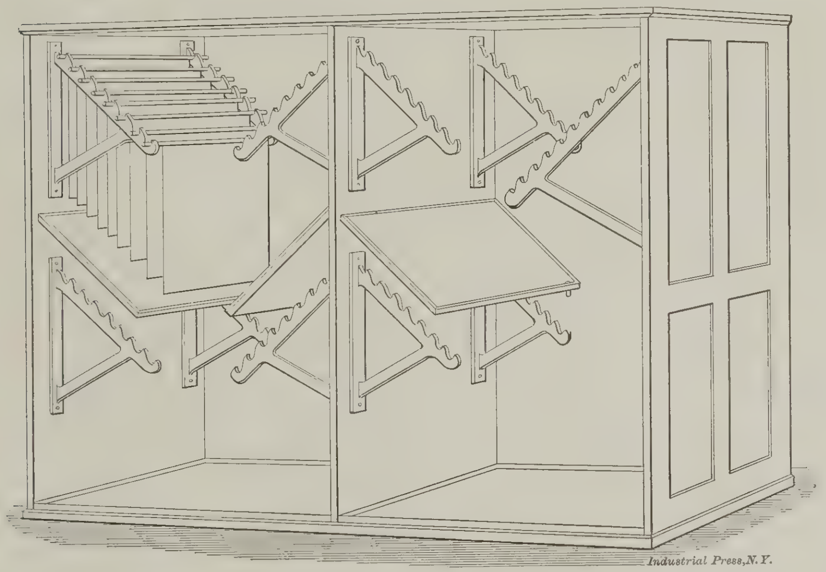
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Fig. 15. Blueprint Drying Racks.

Fig 10, shows a device for supporting large printing frames. This rests on four caster wheels of not less than four inches in diameter. Trunnions are fixed on the sides of the printing frame in a position to exactly balance it, and either the collars of these trunnions should press tightly against the standards, or the trunnions should be considerably larger than those shown, so that the friction will hold the frame in any desired position for printing. The printing frame may be held in a horizontal position for filling by means of the rod pivoted at one end of the frame and having at the other a hook formed upon it which engages a staple in the end of the frame. When in use this frame is rolled to the door of the dark room, the tracing and blueprint paper put in, closed up and rolled out on the platform, thus avoiding much of the usual manual labor in carrying heavy printing frames. Where printing must be done out of a window various forms of tracks and frames must be resorted to, but there are many advantages in so locating the blueprint room as to utilize the roof for supporting a large, level platform, as here described. In cases where no monitor roof or similar facilities are offered, and the roof is nearly level, or with a slight pitch, it will be best to build a printing room on the roof with a platform outside of it, so as to be operated as here described.

A simple washing box is provided for soaking blueprints in the usual way. Also, an automatic print washer, as shown in Figs. 13 and 14. In this device a fixed box has pivoted in it a smaller box, whose bottom is composed of light slats. Upon this box is attached, but so as to be removable, a smaller box with a perforated bottom and divided by a transverse partition set exactly in the center. The operation of the device is as follows: The top box being removed by turning the buttons securing it, the blueprints are laid upon the slats, as many as six or eight at a time, and the top box replaced. The water is turned on at the faucet and one end of the pivoted box is depressed to either of the positions shown by dotted lines in Fig. 14, which will throw the water into the compartment at the higher end of the smallest box. A considerable portion of the water will trickle through the small holes of the top box and upon the blueprints, while the opposite ends of the prints are immersed in the water of the lower box, which is maintained at a constant height by the overflow pipe, as shown in Fig. 14. The perforations in the bottom of the top box not being sufficient to carry off all the water, it gradually fills up that compartment and the pivoted box, thus weighted, is depressed, and the water from the faucet flows into the other compartment and the operation is repeated. The frequency of this rocking movement is easily regulated by the amount of water that flows from the faucet. The operation is not only entirely automatic, but very thorough in its action, as the prints lying upon each other are separated and the upper ones float whenever that end is depressed into the water. The water constantly flowing in and out of the lower box readily eliminates the chemicals that are to be washed out of the prints. So far as he knows, the writer originated this method for washing blueprints and photograph prints and used it with much satisfaction. The boxes may be made of wood and kept well painted; or may be of galvanized iron or zinc protected by paint. The original one was made of white pine, the lower box of 1¼ inch, the pivoted box of ⅞ inch and the top one of ½ inch stuff, and painted with white lead.

For drying blueprints various devices have been used, but so far as the writer knows, nothing is more economical or better adapted to the purpose than the drying case shown in Fig. 15. The plan is to attach the blueprints to small, round sticks by means of small wooden spring clips and hang them on supporting brackets. The brackets are of light cast-iron or wood, as may be preferred, and should incline on an angle of 45 degrees, so that any print may be conveniently reached and removed without removing those in front of it. Two pairs of these brackets are located, one above the other, for medium-sized prints, say 18 x 24 inches, as on the left of the engraving, or one pair for large prints, as shown on the right. The upper section of prints drip the water into a zinc tray supported by a wooden shelf fixed at an angle of 45 degrees, from the lower corner of which, at the back, a short pipe carries the water into a similar tray resting on the floor, and from which suitable pipes carry the water to the waste pipes coming from the print-washing apparatus. The drying of blueprints may, of course, be hastened by the application of artificial heat. For this purpose doors may be added to the drying case and a small steam coil be placed in the bottom or near the back of the case. But to use artificial heat, or any temperature over about one hundred degrees has a tendency to cause the prints to be distorted by unequal shrinkage, and marred by wrinkles, while drying them by the natural temperature of the room, and suspended as in this case, will cause them to come out in good condition.

To adapt this plan of constructing and equipping a drawing room to the wants of larger establishments requiring a larger force of draftsmen it is only necessary to extend its length so as to provide for a greater number of the single and double drawing tables, to any extent required. The capacity for filing drawings, tracings and blueprints should be increased in proportion. One or more large tables for reference drawings will be needed, and the number of lockers increased to accommodate the added force of draftsmen.

Otherwise the same arrangement of the plan need not be disturbed, as the chief's room, photographic dark room, vault and all the other accessories will be either ample, or very easily adapted to an increase to any reasonable extent that may be desired.

* * *

LET US FIRST LEARN TO FLY.

"I wonder if the inventors who are worrying their brains over the solution of the problem of aerial navigation ever give the legal side of the subject a thought?" said an attorney to a New York Tribune reporter. "Probably not, and probably few lawyers have ever thought of their profession in connection with flying through the air; and yet, if we assume that the means of locomotion through the air are equally perfect with those on land and water, it becomes evident at once that there will have to be considerable new legislation to protect both the public and those who engage in transporting passengers and freight through the air. One of the first problems to be settled will be the question of the right of way.

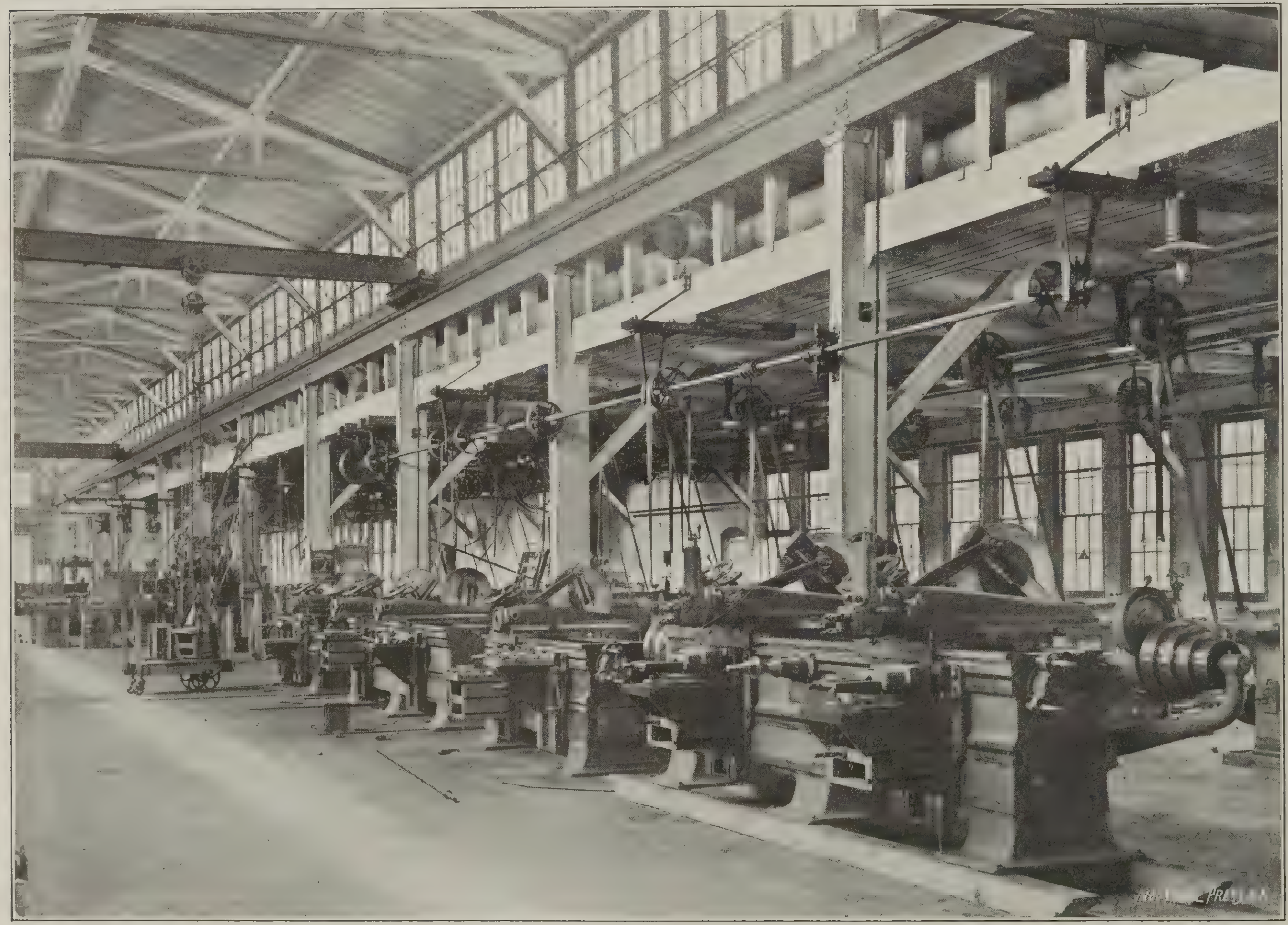

Fig. 1. Interior View of Cincinnati Shaper Co.'s Shop, showing Clearstory Roof Construction, Hand Traveling Cranes, etc.

"Would an aerial line passing over a definite course, at whatever altitude, be a nuisance to an owner of subjacent land, and therefore entitle him to damages for the injury or to compensation for taking of his property? If not, then at what proximity would traffic begin to infringe on his rights? These are important questions and would have to be settled by the lawmakers before a chartered company could run an air line between any two points.

"It might be that the aerial navigators could be sued for trespass, as the common law looks upon the ownership of land as extending to the sky. Consequently a statutory law would have to be passed abrogating the right of the property holder under the common law. Then, too, there is the danger of something falling from the airship, or sky train; and if any loss of life should ensue, or there should be any damage to property, the law must be so framed that the property holder could recover adequate damages. In such an accident it would be difficult to prove contributory negligence."

NEW SHOP OF THE CINCINNATI SHAPER CO.

The great development of the machine tool industry in Cincinnati within the past few years, has, as every one knows, been quite generally along the lines of specialism, most of the makers of this class of machinery in the "Queen" city confining their product to one type of machine tool only. While this tendency has by no means been confined to Cincinnati, this city probably has more shops conducted on these lines than any other. In the census report for 1900 the tendency toward specialism is commented on, from which the following statement is taken:

"This tendency has prevailed in Cincinnati, perhaps, more than in any other city, and has been one of the characteristic features of the rapid expansion of the machine tool industry in that city during the past ten years. During the census year there were in Cincinnati thirty establishments devoted to the manufacture of metal-working machinery, almost exclusively of the classes generally designated as machine tools, and their aggregate product amounted to $3,375,436. In seven shops engine lathes only were made, two (?) were devoted exclusively to planers, two made milling machines only, drilling machines formed the sole product of five establishments, and in three shops shapers only were made. Several other manufacturers made only two or more of these classes of tools, but for the most part the industry was very strikingly specialized."

The Cincinnati Shaper Co., as the firm name denotes, is one of the machine tool specialists referred to, its product consisting solely of crank, geared and traverse shapers. In 1902 the firm erected a new shop in the machine tool district that now stretches along Mill Creek Valley from Eighth Street to Winton Station, and has occupied it since about the first of this year. The shop is of the three-bay, clear-story or monitor roof construction and, of course, is typical of the large class of modern machine shops built along these lines to secure traveling crane facilities and good light. It is a shop, however, that should interest concerns building machinery up to, say, 15 tons (which is the weight of their heavy traverse shapers), who desire a moderate-size shop built with a conservative regard for cost, convenience and efficiency.

The new shop is located on a plot of land 389 x 415 feet, on Beard and Elam Streets, just off Colerain Avenue, and is near the tracks of the B. & O. S.-W. and Big Four railroads, from one of which a switch will eventually be laid to it. The plan is shown in Fig. 2. The total length is 290 feet 10½ inches, and the width, 92 feet 10 inches. A wing was erected at about the middle of the north side for the engine, generator and boiler, and it also contains a wash room, locker room and compartment for the shop heating apparatus. A forge and casehardening furnace are located in the boiler room. The engine is belted to the main lineshaft in the north bay, which is about 220 feet long. The two testing lineshafts, each 90 feet long, are driven by the main lineshaft through belts and friction clutch pulleys. The engine is also belted to a Jantz & Leist 50 K. W. generator which supplies the lighting circuit and the power circuits for the south bay. The electric cables for this section are carried in a conduit under the floor so there is nothing to interfere with the free movement of the traveling cranes along the full length of the erecting floor.

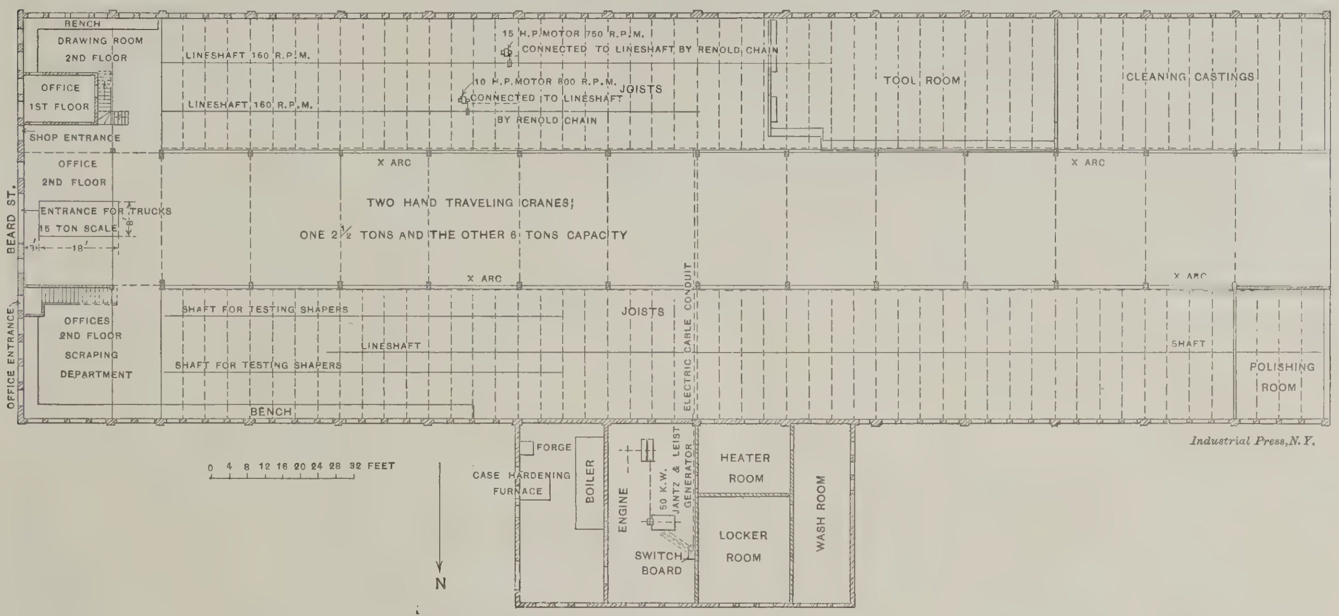

Fig. 2. Ground Plan of Cincinnati Shaper Co.'s Shop.

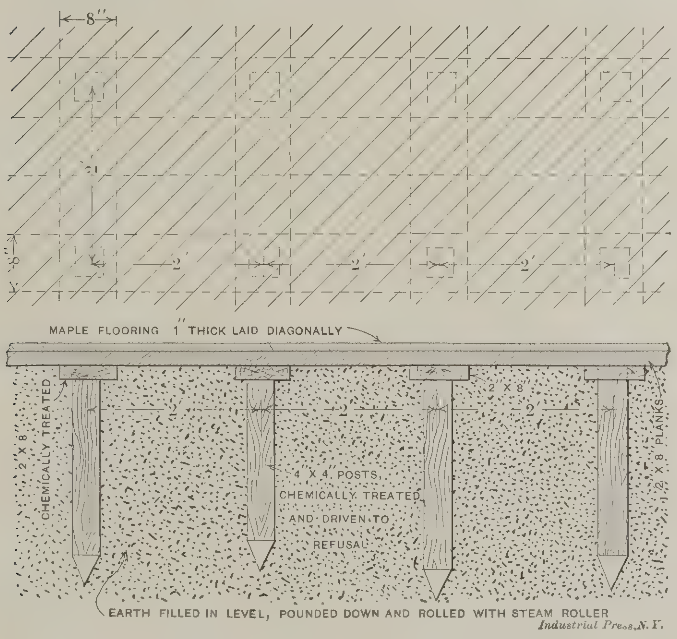
8"
2'
2'
2'
MAPLE FLOORING 1" THICK LAID DIAGONALLY
2 X 8 CHEMICALLY TREATED
2 X 8
4 X 4 POSTS, CHEMICALLY TREATED AND DRIVEN TO REFUSAL
2 X 8 PLANKS
EARTH FILLED IN LEVEL, POUNDED DOWN AND ROLLED WITH STEAM ROLLER
Industrial Press, N. Y.

Fig. 3. Details of Foundation and Floor Construction.

The best floor for a machine shop is a problem that has puzzled many builders, and perhaps the solution has not yet been reached. But where lumber is comparatively cheap, there seems to be nothing yet used that equals it in the matter of cost and general utility. It is not badly damaged by ordinary falls of machinery parts, and the parts themselves do not usually suffer. It is comfortable to work on, and when repairs become necessary they are easily made. The floor of this shop is made of one-inch maple, laid on two-inch planks which are supported as shown in the detail, Fig. 3. The ground was first filled in some parts to a depth of 18 inches to make the surface level. The earth was pounded down and then rolled by a steam roller until it was as solidly compacted as it could be made, mechanically. To support the floor, 4 x 4 inch stakes, sharpened, were driven to refusal with heavy mauls, and the tops sawed off level. Upon each row 2 x 8 inch planks were laid flat and spiked fast, to support floor proper. Both these planks and the stakes were chemically treated to prevent rotting. The stakes were spaced 2 feet apart, center to center, in both directions. Upon and across the planks supported by the stakes, the floor planks were laid and on top of these the maple floor was laid diagonally. The machines are set directly on this floor, save some of the heavier tools which have concrete foundations, notably three Cincinnati No. 4 milling machines, upon which some record performances have been made.

A 15-ton platform scale, 8 x 18 feet, is located in the floor at the street entrance, on which castings brought on trucks can be weighed in bulk. The location of this scale will probably be changed to the opposite end of the shop when the railroad switch is laid, as then the castings will generally be delivered by rail. The plan of the shop and the location of the tools were designed with this condition in view, the casting cleaning department being at that end of the shop as well as the rough and finished material stock rooms. The locations of the machine tools determine the route of the various parts and, as stated, these have been laid down so that stock taken from the material stock room shall traverse its appointed course and return to the finished stock room with the least handling. From thence the parts required for the erection of each shaper are loaded on special trucks, one set only on a truck, and transported to the erecting floor. Of course an exception is made in the case of the heavy parts such as the frames, knees, etc. In connection with the stock room, the plan of keeping track of rough and finished castings is worth noting. Two blackboards, say 4 x 4 feet, are mounted in two pairs of vertical guides, back to back, and connected together by means of ropes running up over pulleys so that one counterbalances the other. When one board is down, the other one is up out of the way, making both sides of each board available for keeping accounts. One board is used for rough castings, and the other for finished stock. They are ruled vertically, two adjacent columns being headed "Patterns" and "Stock" respectively. Following the pattern numbers the number of pieces in stock are written in the column headed "Stock."

As intimated in a preceding paragraph the machinery in the south bay is motor driven. Two lineshafts have been erected, one being about 150 feet long, and the other 120 feet. The longer one was driven by a 15 horse power motor, and the shorter by a 10 horse power motor. Both are connected to the lineshafts by Renold chains. This installation is an instructive example of the great disparity in motor horse power required for individually-driven tools and group-driven tools.

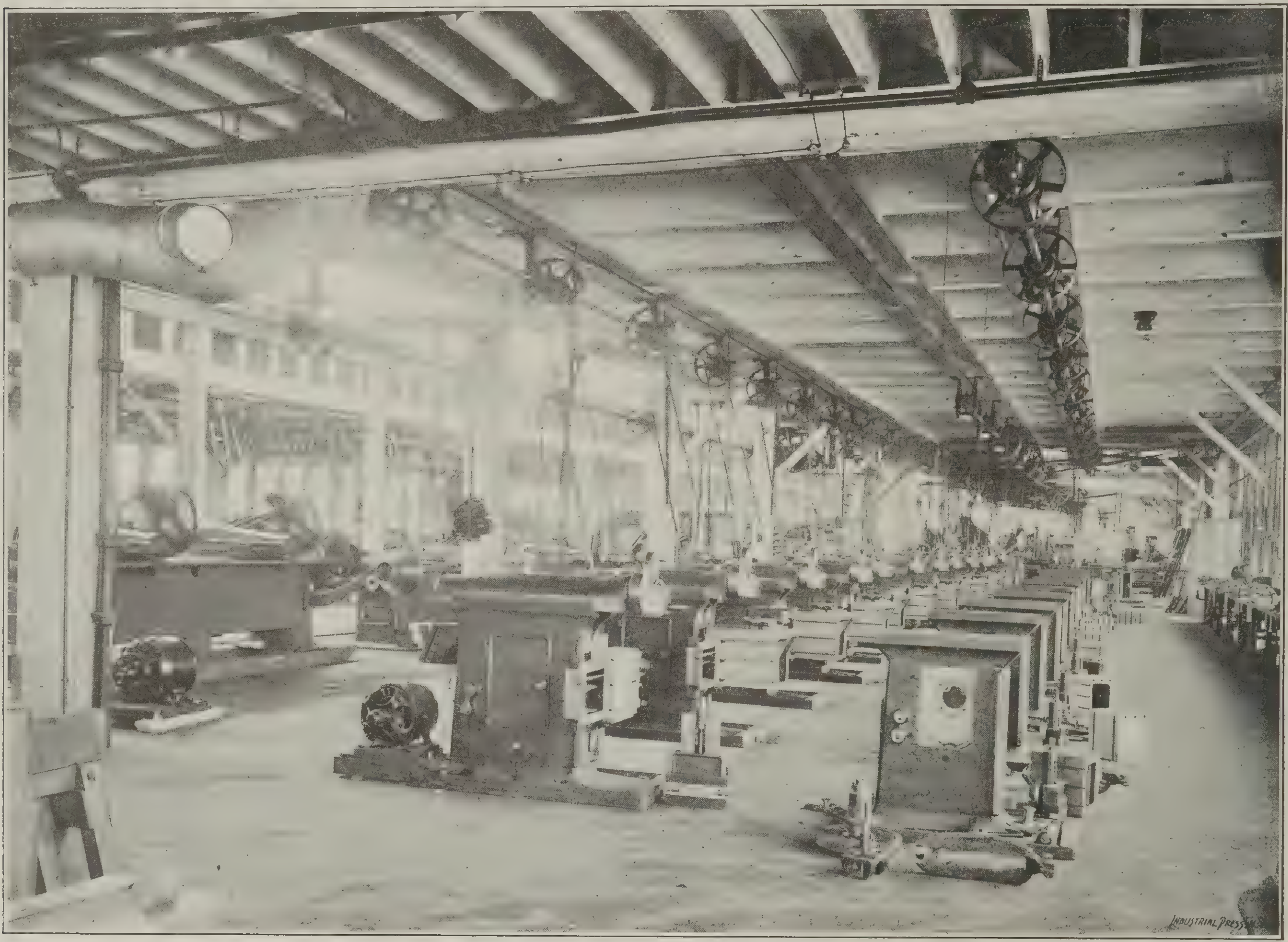

Fig. 4. View from Northeast Corner, showing Shaper Testing Department.

Lineshaft *A*, Fig. 5, drives 12 machine tools; and lineshaft *B*, 19 tools. The maximum power required for each tool was carefully estimated from available data, and the actual power requirement for each group was estimated to be not more than fifty per cent. of the total at any time. Most of the time it was expected that the percentage of power would be still less. The following table gives the estimated maximum power requirements for each group:

LINESHAFT A.

Number of machines.		Estimated H.P.
3	No. 4 plain milling machines, total	6
1	20-in. lever drill	1
1	20-in. chucking lathe	2
1	Jones & Lamson lathe	2
2	25-in. lathes, total	4
1	18-in. lathe	1¾
1	16-in. shaper	1¾
1	Cut-off saw	1
1	Centering machine	½
12	Total	20

LINESHAFT B.

Number of machines.		Estimated H.P.
1	30-in. gear cutter	1½
2	No. 3 plain milling machines, total	3
1	No. 2 Universal milling machine	1½
1	28-in. upright drill	2
1	24-in. upright drill	2
1	Sensitive drill	½
1	No. 2 Universal grinder	4½
1	Jones & Lamson lathe	2
1	15-in. lathe	1
2	16-in. lathes	2
1	14-in. lathe	1
2	19-in. lathes, total	3
1	24-in. shaper	2
1	22-in. planer	3
1	Cutter grinder	1
1	Twist drill grinder	1
19	Total	31

This motor equipment has carried the load quite satisfactorily, but certain changes have since made it necessary to replace the 10 horse power motor with a 15 horse power motor. The lineshafts are belted together so that if one motor is overloaded the other helps it out.

In the north bay are located the radial drills, planers, and the testing floor on which all shapers are run previous to shipment. Two lineshafts, each 90 feet long, are erected for the testing department, each lineshaft accommodating 12 shapers at a time. These lineshafts are driven from the main lineshaft by means of belts and friction pulleys so that either or both can be started and stopped at will without interfering with the main shaft. The testing lineshafts have two sets of pulleys for each shaper stand, so that both crank and geared shapers may be tested with one uniform speed of the lineshaft. Fig. 4 is a view of the testing department taken from the northeast corner of the bay.

The erecting floor or middle bay is 31 feet 4 inches wide. It is served by two hand traveling cranes, one of 2½ tons, and the other of 6 tons capacity. The sides of the monitor are almost solid glass, the window frames being set as closely as possible yet leaving space for the necessary supporting framework. The window frames are pivoted in the center and are connected to shafts operated by worms and wormwheels through vertical shafts from the floor so that the windows of any section may be readily opened for ventilation, etc.

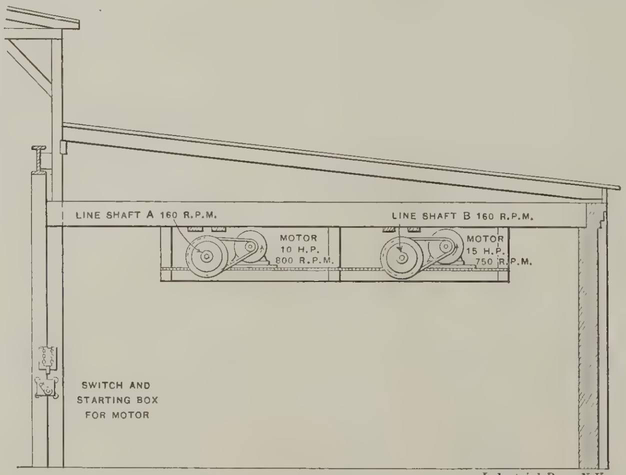

Fig. 5. Arrangement of Lineshaft Motors in South Bay.

Fig. 6 is a sectional elevation of the shop, looking toward the front. Fig. 7 shows the plan of the second floor of the office and a portion of the roof plan of the shop.

Shop Practice.

All shafts are ground to size on a Landis grinder, after having been roughed out in engine and turret lathes. All parts are jigged for drilling, boring and reaming with one important exception. This is the frame of the pillar shapers. For this work a special machine has been made which obviates the necessity for a jig. It consists of two Warner & Swasey boring machine heads, right- and left-hand patterns, mounted on a special frame connecting the two so that their spindles are dead in line. An elevating table with cross-feed makes a combination very similar to the Grand and Bogart double-spindle type of milling machine. A vertical and a horizontal scale gives means for measuring vertical and horizontal distances from certain datum lines, which are laid out on a special drawing for use in connection with this work. The operator sets the shaper frame to be bored so that it rests on the surfaces planed for the ram, which locate it vertically, and the location horizontally is determined from the face of the vertical slide. The location of the various holes is indicated on the special drawing, the distances being indicated from two datum lines which correspond with the zero marks on the scales when the casting is properly set. The holes are drilled and bored with end mills from the two sides simultaneously. The reaming is done from one side only as the reamers are run clear through both holes to insure their perfect alignment. This scheme seems to work satisfactorily in the matter of labor cost, and it must be fairly accurate since the shafts running in the holes bored in this manner carry gears meshing with fixed center distances. Even a slight variation under such circumstances will cause trouble.

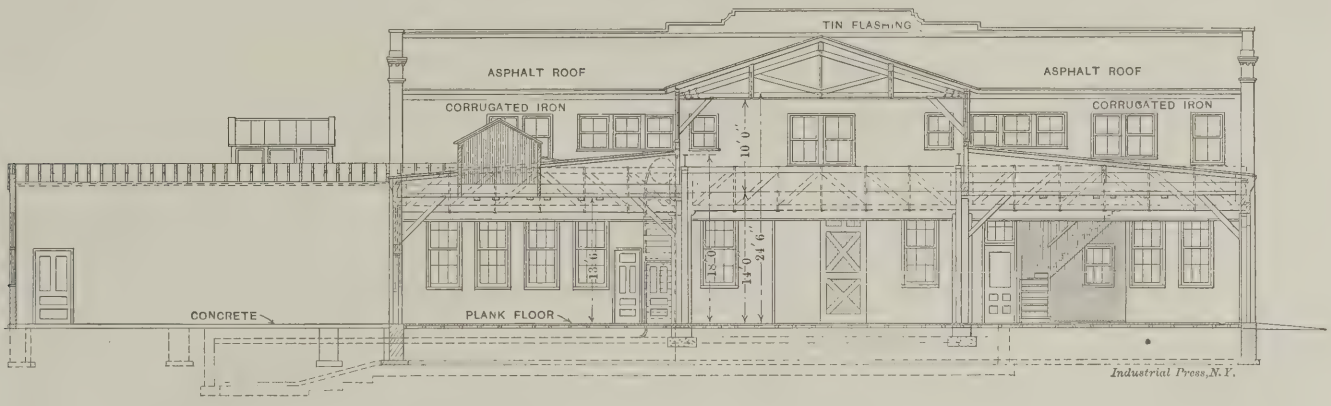

Fig. 6. Sectional Elevation of Shop, looking toward Front.

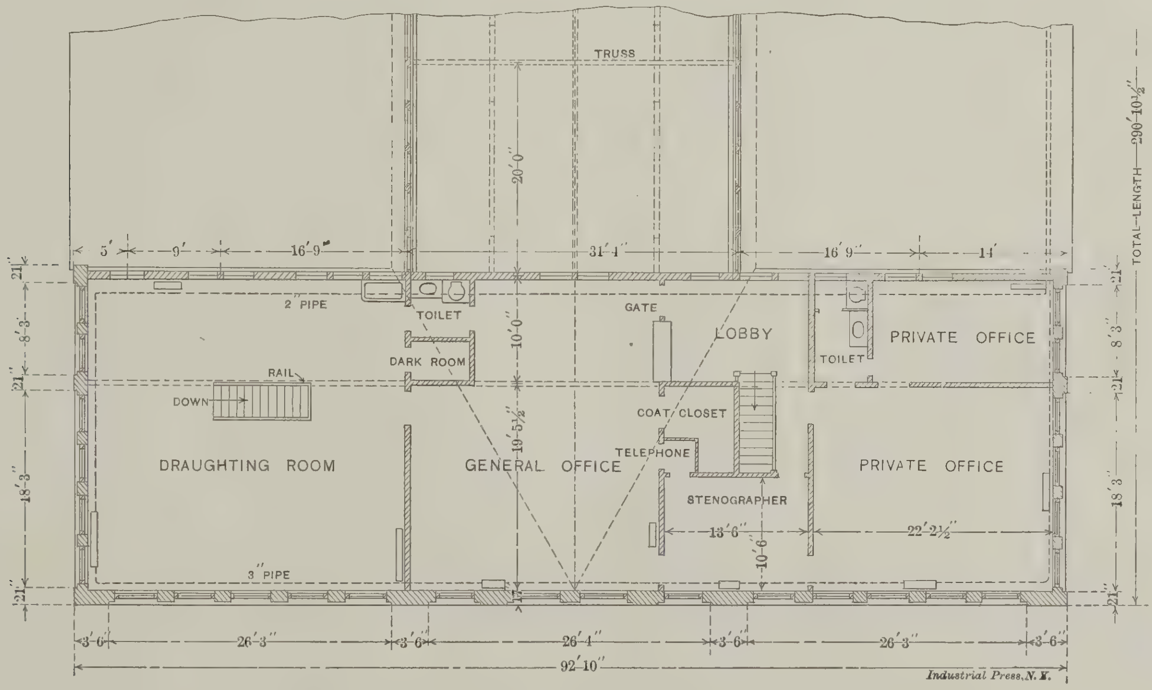

Fig. 7. Second Story Plan, showing Office and Portion of Roof.

A Putnam planer was noticed which has a feature not often found on planers, and that is two driving and two reversing belts, each having its own tight and loose pulleys. The object of this design, which was made to special order, is to give the driving power of a wide belt with the facility of shifting to be obtained only with a narrow belt. In this way a powerful drive can be obtained without the necessity of running at so high a belt speed as to cause disagreeable squeaking and slipping of belts at the reversals of the stroke. Another special feature of planer construction was noticed on another planer to enable the side heads to be used on both sides of shaper ram slides. With the side-heads extended sufficiently for such work, the overhang is so great that heavy cuts could not be taken. To support the slides a planed strip is bolted to the inside of each planer upright some distance back of the cross-rail. Two castings about three feet long with dove-tailed ends, are clamped in a horizontal position to the slides of the side-heads, with their opposite ends abutting against the strips bolted to the uprights. In this manner the thrust of the tools is transmitted to the uprights through the struts, thus relieving the side-heads of pratically all stress. Vertical movement, of course, is not interfered with since the ends of the struts abut against the vertical strips which offer no resistance to movement except in the direction of the thrust of the tools.

In the tool room special trucks are provided to transport the jigs and tools required on certain pieces, and each truck is reserved for that particular purpose. That is, instead of unloading a truck with all the attendant labor, whenever the jigs and tools are returned, it is left loaded until required for the next job and then all there is to do is to haul it to the drill-press where wanted. This plan would require considerable floor space in the tool room for the storage of all the trucks, but since a certain proportion are always out in the shop, this is not a serious objection. The convenience of handling jigs this way is apparent.

* * *

FIRST STEAM ENGINE IN AMERICA.

The first steam engine in America was imported in 1753 by Col. John Schuyler for use in pumping out his copper mine opposite Belleville, near Newark, N. J. This mine was rich in ore and was discovered by a curious chance. One of the Schuylers was plowing in a field when his negro slave found a large stone that was unusually heavy. His master saw that it contained copper and sent it to England for inspection, where it was pronounced 80 per cent. copper. Upon receiving the report Schuyler gave his negro his freedom and granted him three wishes. The old darky scratched his head and for the first wish chose to live with his master and have all the tobacco he could use; for his second wish, a dressing gown with brass buttons, like his master's; and for his third wish, more tobacco.

Col. Schuyler's mine had been worked as deep as hand and horse power could clear it of water. Its proprietor, having heard with what success steam engines, then called fire engines, were used in draining the mines of Cornwall, determined to have one in his own mine. He accordingly requested his London correspondent to procure an engine and to send out with it an engineer capable of putting it up and running it. A Hornblower engine was, accordingly, ordered, and Joseph Hornblower, one of the sons of the builder, became interested in the machine and came over to erect and operate it, expecting to return later. The voyage was a long and perilous one, and Mr. Hornblower's services proved so satisfactory that the proprietor induced him to remain—all the more willingly, probably, because the American girl had proved as attractive to him as she has to many other men from foreign lands, the girl in this instance being a Miss Kingsland, whom he married.

Josiah Hornblower's father, whose name was Joseph, had been engaged in the business of constructing steam engines in Cornwall from their first introduction in the mines there, about 1740; and had been an engineer and engine builder from the first use of steam engines in the arts, about 1720. The engines constructed by him and his sons were Newcomen engines, or Cornish engines, using steam at atmospheric pressure. There was an immense wooden walking beam, with a segment at each end from which hung chains; the chain from one end attaching to the pump rod and from the other end to the piston rod. The pump rod descended by its own weight and was pulled up again by the air pressure on top of the piston, the steam having been condensed under the piston by a spray of water, producing a partial vacuum.

At the time Hornblower's engines were built, Watt had not invented his separate condenser, nor discovered the use of high-pressure steam. After 1760 the Schuyler mine was worked for several years by Mr. Hornblower himself.

* * *

EXAMPLES OF INERTIA.

We are all familiar with many experiments to demonstrate the inertia of matter, sometimes called the passiveness of matter—its dislike to get into motion when at rest and its desire to keep moving when once in motion. One of these is the old trick of firing a candle through a door panel. The candle travels so rapidly that when it strikes the door its particles do not have time to slide one upon another, and the soft candle flatten out, as would be expected; but instead it will crash through the wooden door, if we are to believe our text books. Whether it actually would do this or not can only be told by those who have performed the experiment, which would seem to be rather a dangerous one, owing to the possibility of bursting the gun. It is known, moreover, that a person hunting in the winter-time should be careful not to run the muzzle of his gun into the snow, lest the end of the bore become filled with snow and the gun burst when fired. While the snow would be almost infinitesimal in weight, it would have to start instantly into motion, at the rate of perhaps a third of a mile a second, when the powder ignited. While it may be hard to realize it, more force would probably be required to accomplish this result than the strength of the gun barrel could stand and the barrel would rupture under the strain.

Examples like the foregoing are very familiar, but some other tests quite as instructive, but more out of the ordinary, have recently been explained before the Royal Society of London. The tests were first made with a copper sphere about 5 inches in diameter, in the center of which was a glass flask about 1 to 1½ inches diameter, retained in position by cotton packing. The sphere was perforated to allow water to enter its interior and then it was sunk in the ocean on the end of a sounding cord to a great depth. The pressure of the water increased, of course, as the sphere descended, until it became so great as to burst the glass flask, which was filled only with air. This gave a momentary relief to the high pressure within the sphere, and its copper walls collapsed. The inertia of the water was so great that it could not be set in motion quickly enough to fill the space occupied by the glass flask before the collapse of the outer sphere. Another similar test was made with a copper tube, open at the ends, and containing a small glass vial. When sunk sufficiently deep the vial crushed, relieved the pressure within the tube and the latter collapsed, before the water had time to run into the ends of the tube for the support of the metal walls. These tests are all the more striking when it is remembered that the water was under such high pressure at the depth of the sphere or tube, that it must have flowed at an extremely high velocity into the sphere or the ends of the tubes; but yet it was too late to prevent the action cited.

* * *

RAPID COAL HANDLING.

In the last number we published a brief item in regard to the coal handling machinery installed by the C. W. Hunt Company at the Lincoln Wharf Power Station of the Boston Elevated road, which marks a decided advance in the speed with which coal has heretofore been hoisted from barges, cracked to uniform size and delivered to storage pockets. The installation consists of two hoisting towers with the moving gear and coal cracker electrically driven and the hoisting engine direct-connected. The towers have to traverse overhead the whole length of the coal storage pocket and to move 30 feet at a time without changing steam connection. The boom of each tower has an overhang of 40 feet. With one of these towers run-of-mine bituminous coal was raised 90 feet above the tide water from one hatch of a vessel and delivered to the storage pockets, cracked to a mechanical-stoking size, at the rate of 320 tons per hour, by one tower.

To attain this end, the steam engines of fifty to one hundred combined horse power in common use have been replaced by machinery of three hundred horse power, and the coal-cracking machine attached to the tower cracks to the proper dimensions for automatic stokers, before passing to the pocket the enormous quantity of coal over five tons per minute, delivered to it from the hoisting machinery. The ordinary small steam shovel has been supplanted by an automatic one of two tons capacity at each lift.

The time occupied in raising two tons of coal from the hold of a vessel to the discharging hopper, nearly one hundred feet above, is only six seconds, while the round trip, involving the operations of lowering and moving the shovel out of the boom, opening the former, digging up two tons of coal, raising it to the level of the hopper and discharging it therein, is frequently performed in twenty-two seconds.

The work demanded of coal hoisting towers and their machinery is of the hardest description, both from the unskilled nature of the labor employed, and the shocks to the machinery incidental to the service; and it changes constantly with the nature and size of the coal, which may vary from a soft pea variety contained in open wooden barges, to a hard foreign product in cubes, two feet square, loaded in steel vessels with small hatches.

FOUNDRY AND PATTERN DEPARTMENTS OF THE B. F. STURTEVANT COMPANY.

In November of last year we published an outline of the preliminary plans for the new works of the B. F. Sturtevant Company, at Hyde Park, Mass. Since that time the plant has been nearly completed and occupied and we give herewith a general description of the pattern and foundry departments. The new works were commenced shortly after the destruction of the greater portion of the old works at Jamaica Plain, Mass., by a disastrous fire, and afford over double the space of the latter, an increase in facilities that was much needed by the rapidly growing business of the firm. The new plant comprises a commodious office building; a building devoted to the manufacture of blowers, heaters and galvanized iron work; a building for the electrical department, and for testing steam engines; a general machine shop, used mainly for engine building; a forge shop; foundry; pattern building, and power house.

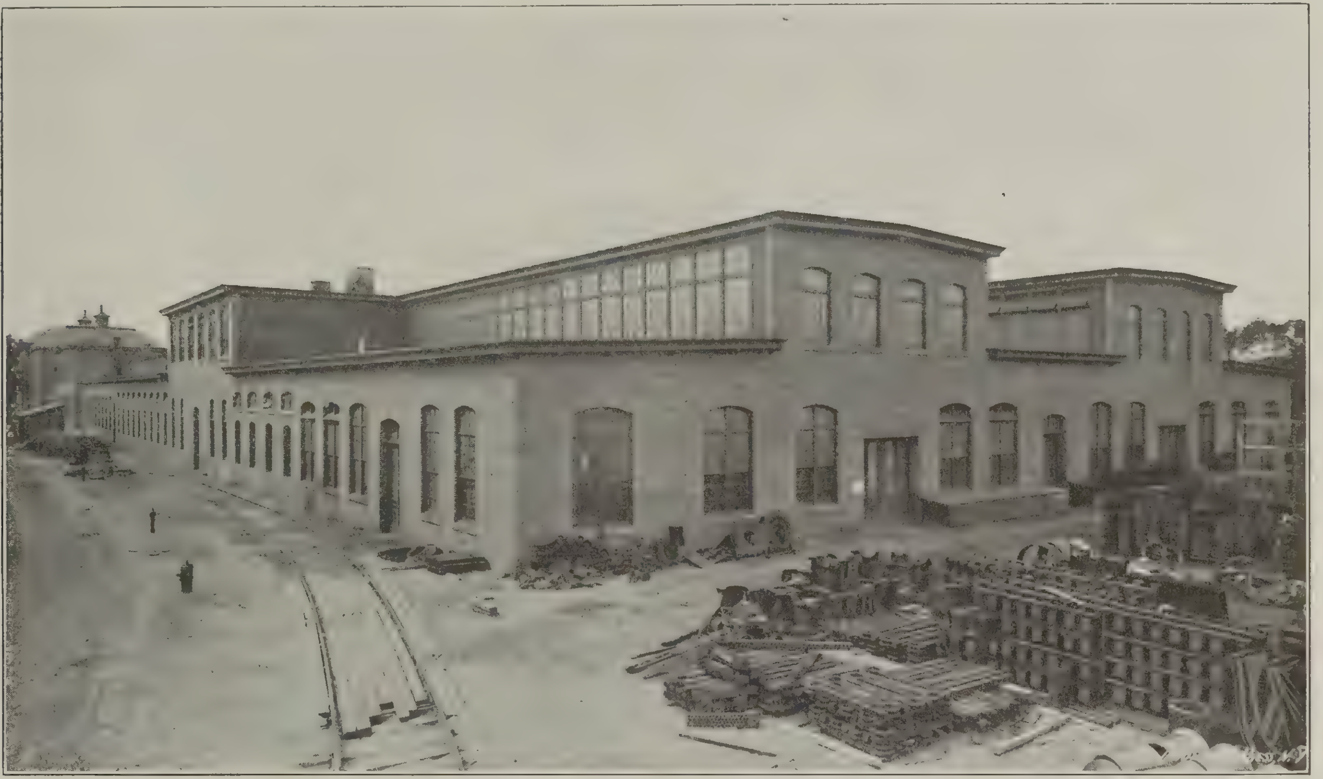

Fig. 1. New Foundry of the B. F. Sturtevant Company.

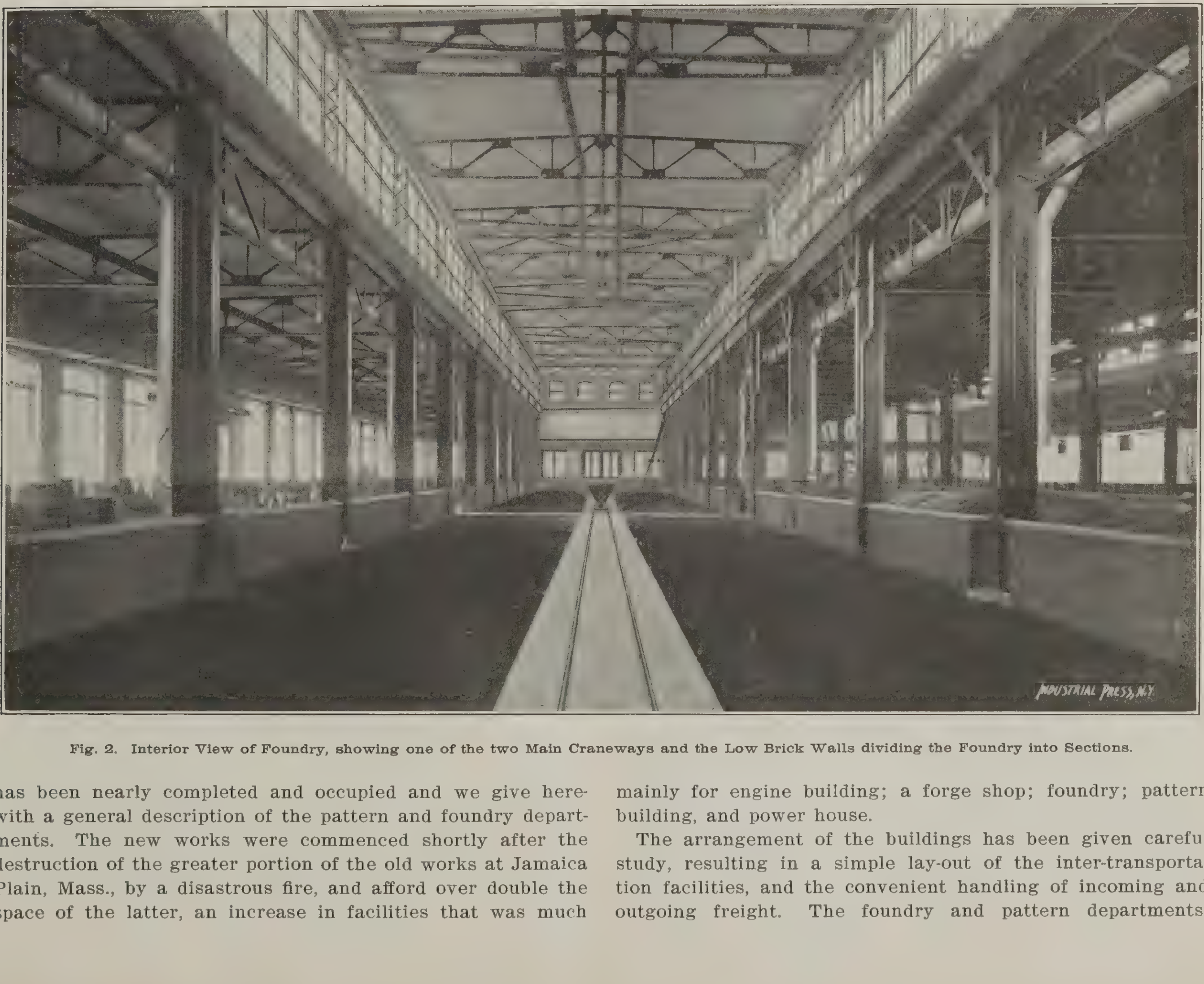

Fig. 2. Interior View of Foundry, showing one of the two Main Craneways and the Low Brick Walls dividing the Foundry into Sections.

The arrangement of the buildings has been given careful study, resulting in a simple lay-out of the inter-transportation facilities, and the convenient handling of incoming and outgoing freight. The foundry and pattern departments, which form the subject of this description were the first to be put in operation prior to the removal of the entire plant from Jamaica Plain.

The Pattern Building.

The pattern building is divided midway of its length by fire walls enclosing stairs, elevators, etc. One-half the building, with stories respectively 17 and 15 feet, is devoted to the flask and patternmaking rooms, while the other half, provided with intermediate floors, making four in all, is utilized for pattern storage. The spacing of the floors will be evident from the exterior view in Fig. 7.

The industrial railway runs directly into the flask shop from the foundry and together with an overhead transfer track reduces to a minimum the cost of handling flasks. The lumber is unloaded from cars directly in front of the building. This room also includes the metal patternmakers' department.

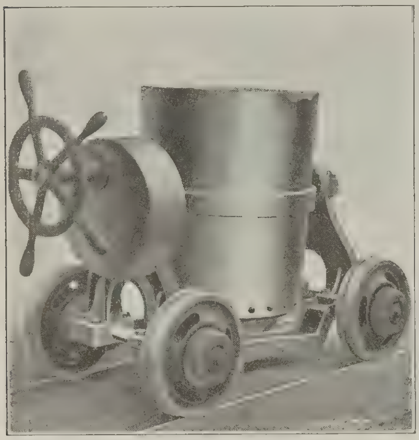

Fig. 3. One-ton Spur Gear Ladle Truck.

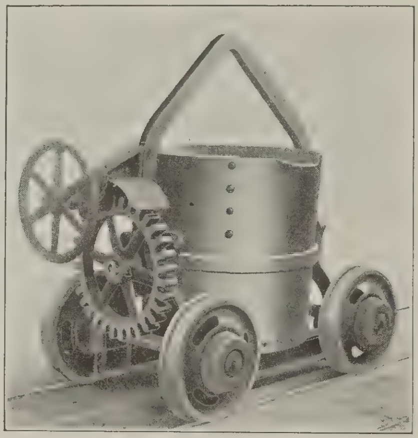

Fig. 4. Transfer Truck for Crane Ladle.

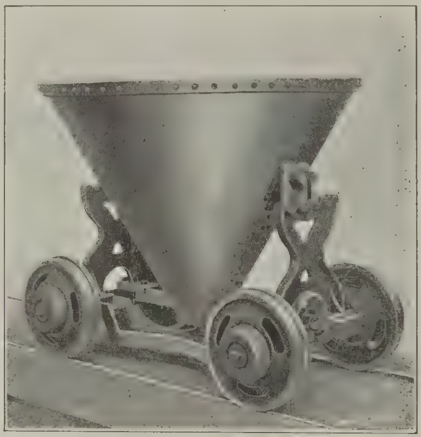

Fig. 5. Dump Car.

Immediately above the flask shop is the pattern shop, abundantly lighted upon three sides and equipped with a full complement of tools. The benches accommodate two men each and measure 2 feet 6 inches in width by 16 feet in length. They are so arranged along the sides of the building that the men all receive a left-shoulder light. Behind each bench is a working table 4 feet by 16 feet in dimensions. The benches are supported upon cast iron legs of special design which were built by the Sturtevant Company and are used throughout the plant. They are equipped with Emmert vises and their tops are of heavy maple plank. A warming chamber for glued work is provided which receives warm air through the heat flue. Sturtevant motors are employed in this building, in 10 horse power units, which provides for a relay in case of a breakdown.

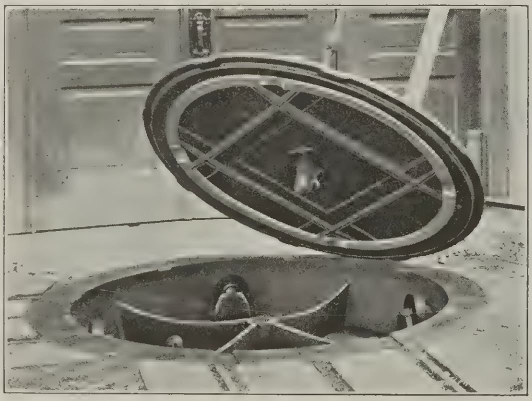

Fig. 6. Turntable for Industrial Railway, with Cover Lifted.

Around the pipe columns which support the floors of the pattern storage end of the building are clamped the pattern shelving brackets which are adjustable to any height. All patterns are consecutively numbered upon the drawings as made. When delivered to the pattern storage department proper locations are assigned, and records thereof made upon cards, one for each pattern. These cards are filed in the order of the pattern numbers. Four figures with the addition of a letter are in every case sufficient to locate a pattern. A given location, for instance, may be 2125B; that is, it is upon the second floor, as shown by the first numeral, "2"; it is in the twelfth row of shelves and the third division of that row, as shown by the succeeding numerals "125," and on the B level, the floor being designated A, and the letters B, C, D, etc., indicating the shelves in their order above.

The first floor is of concrete and is designed for the keeping of heavy cast iron patterns. It is served by an industrial railway and turntable which permits of transfer to the elevator and thence to other floors. Communication between the pattern shop and storage department is direct, while the fire risk is reduced to a minimum by a double system of fire doors.

The molder's written order to make a specified number of castings is issued by the foundry office, directly to the pattern keeper, who makes record thereon of the pattern location, attaches it to the pattern and sends both to the foundry. A metal clip placed upon the storage record card indicates that the pattern is out.

The Foundry.

The foundry consists essentially of two long craneways, each 35 feet in width, with center bent of the same width and side floors 30 feet wide. The brass foundry, core room and wash room are located at one end; the charging floor at one side, nearly midway of the length, and the cleaning room at the other end. The craneways are designed for 20-ton electric traveling cranes. Those already installed are of the Whiting Foundry Equipment Company's make and are equipped with Sturtevant motors.

A feature of the foundry arrangement is the location of two division walls 3½ feet high, so as to separate the floor into three divisions on the lines of the columns. Breaks in these walls occur at intervals, allowing passage from one division to another. The walls serve the purpose of dividing the foundry into different sections for different classes of work, without actually making several separate rooms or buildings, and also serve as extra wall space against which flasks or tools can be leaned.

In the center line of each of the craneways and in the bent between them runs an industrial railway with turntables connecting with the cross aisles which provides for the distribution of metal, etc., to all parts of the building. The floor between the craneways is supplied with a series of 1½-ton small traveling cranes of about 10-foot span equipped with Sturtevant electric hoists built especially for this work.

All materials are received from a track which runs along one side of the foundry and are delivered through wall openings to the bins which fill a portion of the side wing adjacent to the cupolas. These various features appear in the three interior views of the foundry herewith.

Lighting is secured through side windows and monitors. Each line of monitor transoms is operated in unison by a novel device installed by the G. Drouve Company. The western side of the foundry is given up to bench and small floor molding, the bench molders' floors being separated at the

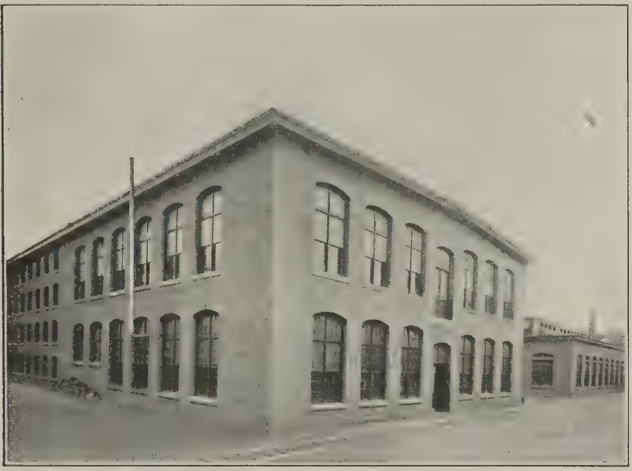

Fig. 7. Woodworking and Pattern Storage Building.

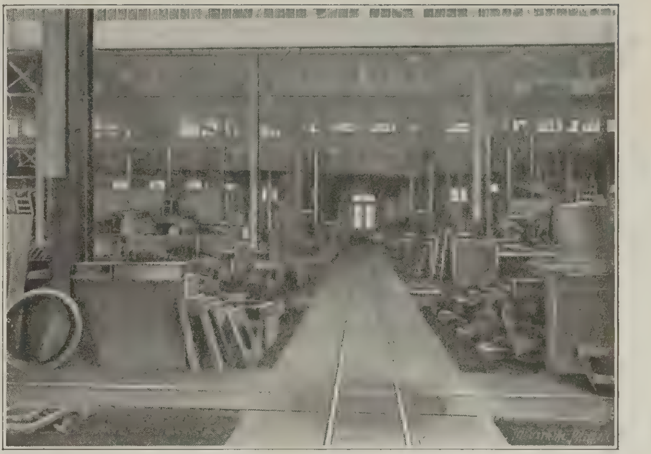

Fig. 8. Looking Across the Foundry.

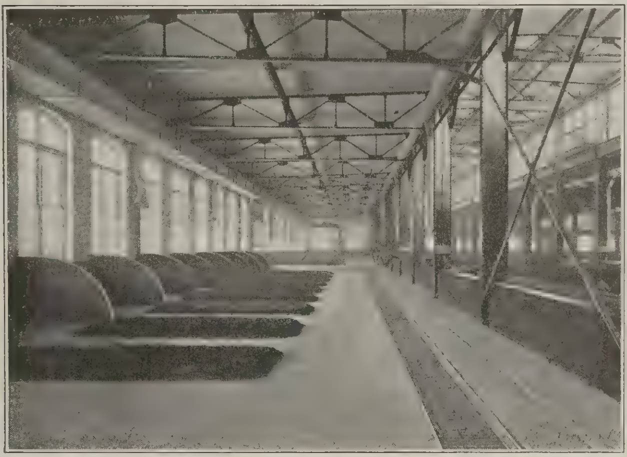

Fig. 9. Interior, showing one of the Side Bents of Foundry.

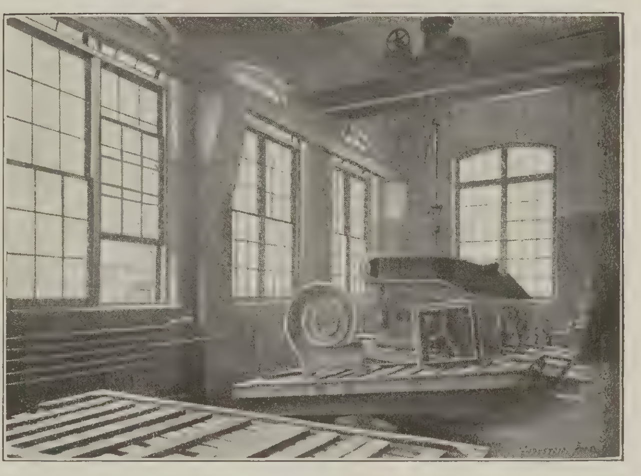

Fig. 10. Pickle Room.

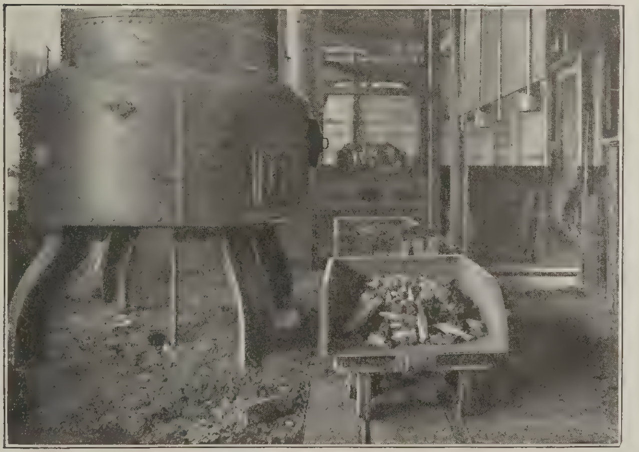

Fig 11. Charging Car, Ground Floor at Cupola.

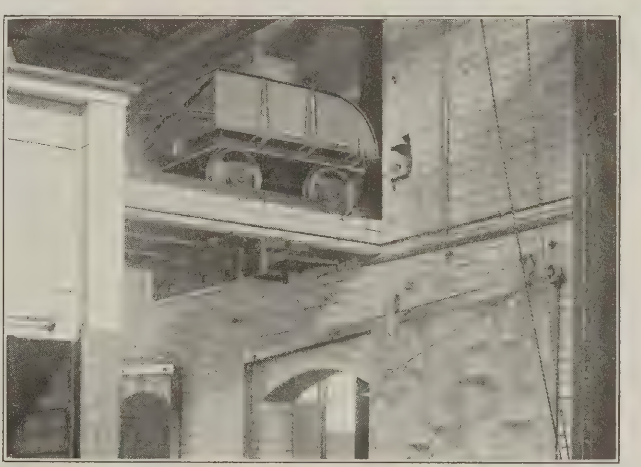

Fig. 12. Car Entering Drop Elevator.

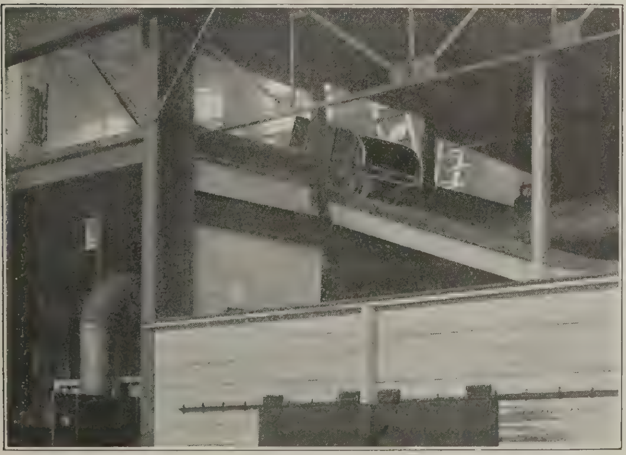

Fig. 13. Car Entering Chute.

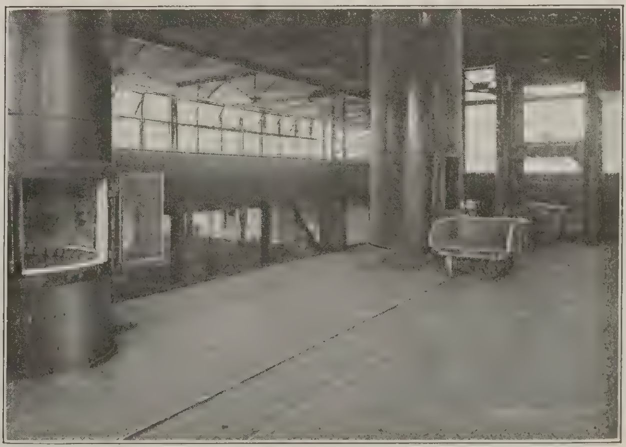

Fig. 14. Cars on Charging Floor.

VIEWS OF THE NEW B. F. STURTEVANT FOUNDRY AND PATTERN BUILDING.

bench ends by wooden partitions. The floors throughout this side of the building as well as those in the storage bins and center runways are of concrete. Alongside the industrial railway, which serves iron from ladle trucks to the bench floors, is a sunken trench laid with common brick as a suitable place for drippings and for the piling of hot castings.

The Cupola Arrangement.

An ingenious system of charging has been devised under which the charging cars pass at floor level in front of the bins, are there loaded with the requisite amounts, weighed, and passed to the elevator where they are raised to the charging floor. As each car is unloaded it is pushed forward and started down an incline whence it passes back in a direction opposite to that traversed while being loaded on the floor beneath. A novel apparatus gradually brings it to a standstill while yet upon the incline, and then releases it so that it may, by its own weight, roll onto an elevator which is automatically tripped and descends to the ground floor level. Here it is removed by one of the loading men and the elevator returned to its place above, ready to receive another load. A number of views are shown of the charging car in several positions.

The cupolas are two in number, of Whiting make, 54 and 72 inches in diameter, and the blast is secured by Sturtevant pressure blowers; a No. 8 and a No. 10 blower are driven respectively by a 30 and a 40 horse power belted motor, being supported upon the charging platform through which they discharge directly downward and thence to the cupolas. It is intended to make this installation the subject of critical experiment for the establishment of important principles.

The entire transportation equipment of the plant, including tracks, cars, trucks, etc., was designed and built by the Sturtevant Company. The tracks in the foundry are imbedded in the concrete runways and all changes of direction are secured by turntables, there being no switches in the works, and therefore no radial truck cars, all cars having rigid bases. The turntables are designed very heavy to avoid distortion or breakage and consist of a bottom frame with four roller wheels, Fig. 6, which are carried upon composition trunnions, and a cover, which is recessed for crossing tracks at right angles, and is provided on the underside with a chilled tread, with which the wheels come in contact. A small idler wheel is provided which automatically stops the turntable on each quarter, but readily releases it. The cover is accurately centered by a chilled conical bearing.

The cars are provided with a special type of ball bearing, practically devoid of machine work, but with chilled wearing surfaces. The ordinary flat cars, as well as the charging cars, are built up of structural steel. The geared ladle cars have malleable iron frames and enclosed spur gear mechanism. Similar construction is employed in the case of the transfer cars for geared crane ladles of medium size, while a simple low platform truck is utilized in the case of the largest crane ladles. The dump cars are in the form of inverted cones and so balanced as to be tipped with the utmost ease. The taper of the cone is such that these cars are practically self-dumping.

Brass Foundry.

The brass foundry, located at one corner of the main building, is provided with four crucible furnaces and a special form of reverberatory furnace designed principally for the melting of babbitt or similar soft metals. An overhead traveler with interlocking transfers on the side floors serves the entire area of the room.

In the middle of the end of the foundry is the core room. The ovens are six in number, three being 7 feet in diameter, of the reel type and three being respectively 4, 5 and 7 feet in width by 8 feet 10 inches in length, provided with cars. An overhead traveling crane serves these latter ovens and provides for the transfer of heavy cores to the industrial railway which passes through this room. A portion of the room is partitioned off and serves for the women core makers employed in this department. The floor is of concrete. The tops of the ovens are utilized for storage of cores upon a special rack of steel construction.

At the other end of the foundry is the cleaning room, through which run the longitudinal tracks from each main aisle of the foundry. A five-ton three-motor electric crane of the Whiting Foundry Equipment Company's manufacture equipped with Sturtevant motors serves the principal portion of the floor in this room. The tumbling barrels, six in number, are completely enclosed in housings of steel construction. These, together with a Sly cinder mill and several emery wheels are driven by a 30 horse power Sturtevant motion. A temporary air compressor, located in one corner, supplies air at 100 pounds pressure to chippers, stokers, hoists, etc., employed in connection with this work. The light and ventilation of this room are noticeably good.

Adjacent to the cleaning room is the pickle room, Fig. 10. The floors of both are of concrete. The pickle beds are of teeter board construction so designed that the acid may be drained back into the vats and the board subsequently teetered over for washing into the trench upon the other side of the room. The floor slopes for drainage. A pneumatic traveling crane serves this room.

One of the notable features of the equipment of this plant is to be found in the sanitary arrangements. Most generous provision has been made in the case of the foundry, which has a large locker and wash room. Expanded metal lockers to the number of 225 are already in position. Enameled iron sinks, six in number, are served with tempered water and are generously patronized by the employees. A series of slate partitioned shower baths has proved to be very acceptable during the past summer. The floor of this room is of tar concrete; the upper walls and ceilings which are white and fresh are in pleasing contrast with the steel work and base of the walls which are finished in rich dark green. Within the same room is installed the time-recording system, so placed that a double line of men pass, one upon either side of the board, as they go and come from the room. The foundry foreman has not been forgotten in the matter of convenience, and he with his assistants is provided with an attractive office, well lighted and susceptible of thorough ventilation from out of doors.

The entire plant is heated and ventilated by the Sturtevant system. In the case of the pattern building, the apparatus consisting of an engine-driven fan and steel pipe heater is placed close to the division wall and delivers the heated air into a vertical flue and thence to the various rooms. The foundry apparatus is located overhead in the end of one of the craneways and arranged to take fresh air from out of doors or return from the building and reheat it. Distribution of air is made through a system of overhead galvanized iron piping, discharging downward to the floor. Both apparatus utilize exhaust steam. A complete underground tunnel system is provided for distribution of steam, electricity, compressed air, etc., and return of condensation.

* * *

What is said to be the most dangerous railway in the world is that recently completed up the side of Mt. Vesuvius for the benefit of the many tourists that annually visit this famous volcano. It is a cable railway of the mono-rail type, the one car comprising the active rolling stock being supported by two wheels, one at each end of the car. The center of gravity of the car is below the top of the supporting rail so that it balances without the aid of supporting wheels at the sides. The railway line runs to within nominally 1,000 feet of the crater mouth, but the distance changes from day to day on account of the rapid changes that take place; accretions to the sides of the crater may materially increase the distance one day, and the fall of a huge slice into the seething gulf 500 feet below, may considerably lessen the distance the next day. The maintenance of the line in proper alignment is a difficult matter. Fissures opening, the flow of lava, falling cinders, and sliding of the roadbed require constant watchfulness and labor by gangs of laborers who constantly patrol it during the periods of operation. The "train" has no fixed time-table, the trips depending on the activity of the volcano and direction of the wind; some days they are entirely abandoned.

ALTERNATING CURRENT RAILWAY MOTOR.

United States Consul-General Mason, Berlin, Germany, has been more active in collecting and sending information to this country upon technical and engineering subjects than any of our foreign representatives. In a recent consular report he devotes considerable space to a general description of a new variable speed motor for electric cars operating with a single-phase alternating current of 6,000 volts, without conversion to a lower voltage or to direct current. A car equipped with one of these motors has been in operation on a Berlin suburban line and it is stated that its speed can be varied to any desired degree without cumbersome or expensive regulating devices. The motor was invented by a young Austrian electrician and built from his plans by the Union Electric Company, Berlin. If the motor should prove on extended trial to accomplish all claimed for it, it is an invention of great importance, for it apparently accomplishes a result not heretofore attained. Readers may possibly remember the description of the Arnold system of electric traction in the technical press about a year ago, in which system alternating current motors are employed. But Mr. Arnold found it necessary to provide a compressed-air storage reservoir and an air engine, connected with the electric motor and also the car axle by suitable mechanism, in order to obtain the full variation in speed desired. Various other systems, more or less complicated, have been worked out to avoid direct-current motors on electric cars and the consequent converter and transformer stations along the line of the road, in installations where alternating current is used for the transmission.

No information is at hand regarding details of the new Austrian motor, but Consul-General Mason's description and very intelligent comments are of interest. He says that alternating currents of high pressure, which are taken off at intervals by substations, as mentioned above, work very well for short suburban and city lines. But when the proposition is to extend the same practice to a standard railway, connecting two cities from 100 to 300 miles apart, the cost of the installation and working expenses become practically prohibitive. Besides the frequent substations equipped with converters and transformers capable of changing the high-voltage alternating current into a low-pressure continuous one, there is the question of heavy copper conductors throughout the line, and this, added to the fact that the transformers and rotary converters must stand idle except when the converted current is taken off and used by some passing train, has hitherto rendered the proposition economically untenable.

When the high-speed experiments were tried last year on the government railway line between Marienfelde and Zossen, an alternating three-phase current of 10,000 to 12 000 volts was carried along the line on three copper wires and conducted thence by trolleys to transformers carried under the floor of the car, whence it was transformed to 1,150 to 1,800 volts and passed into the three-phase induction motors. The car easily attained a speed of 140 to 150 kilometers an hour, at which pace the rails began to give way. The experiments had to be postponed until a more solid and substantial track could be provided, but have recently been conducted successfully.

The present experiment has therefore a wholly different purpose. It involves no question of extreme high speed, but rather the transmission of a single-phase alternating current at a voltage sufficient to carry it over a long line on a small and relatively inexpensive wire, and the direct use of the current, without transformation, by a motor capable of running economically at any desirable speed and which fulfills all the other requirements of electric traction. The point demonstrated by the tests now in progress is the effectiveness of the new motor for the special purpose to which it is applied. No sparking or other technical difficulty appears thus far to shadow the success of the experiments. The system eliminates the expensive substations, with their heavy initial outlay and operating expenses, and is so simple and direct in its working that it may, at least in theory, be applied to lines several hundred miles in length. If the distances are very great, of course the power may be transmitted from a distant waterfall or steam plant at any desired pressure—say, 20,000 or 50,000 volts—and then reduced in ordinary transformers, requiring no especial care, to the working-line voltage of, say, 6,000 or more. The present tests are over a line of 3 or 4 miles in extent, the length being immaterial. There may be encountered new technical difficulties when this distance is increased to as many hundred miles, but such difficulties are only such as may be met in any long-distance transmission and such as electrical science at its present stage is fully prepared to overcome.

* * *

OF HISTORICAL INTEREST.

In a brief paper read before the Engineers' Society of Western Pennsylvania on early experiences in transportation, Mr. Antes Snyder referred to the regulations promulgated for the control of traffic on the State railways of Pennsylvania. When the commonwealth opened the Philadelphia and Columbia Railway, the theory was that the State furnish the roadway, and that any one who pleased could furnish his own vehicle and motive power and use the railway whenever he wished, by paying the State tolls for its use, just as the turnpikes of the day were used. But it was soon discovered that a certain character of vehicle was necessary and that rules and regulations as to times and manner of using the railways were absolutely necessary to effect their successful operation. The ordinary shippers found it too expensive to fit themselves with the necessary plant, and that they could get this transportation done by large and well-equipped shippers much more cheaply than they could do it themselves, so that in pracice the business drifted into the hands of a few individuals and companies, who did this service for the many. The railway as constructed was intended for the horse as motive power, though the locomotive was being introduced as an experiment shortly after the railway was completed. The following, among the rules and regulations adopted by the Canal Commission for the regulation of the railway, may be of interest:

"Section 92.—No car shall carry a greater load than three tons on the Columbia and Philadelphia Railway, nor more than three and one-half tons on the Portage Railway, nor shall any burden car travel at a greater speed than five miles per hour, unless the car body and load shall be supported on good steel springs.

"Section 108.—It shall be the duty of the conductors of cars moving with less speed upon the railways, upon notice by ringing a bell, blowing a horn, or otherwise, of the approach of a locomotive engine or other cars moving in the same direction at a greater speed, to proceed with all possible dispatch to the first switch in the course of their passage and pass off said track until said locomotive engine or other cars moving at greater speed can pass by. The conductors of the slower cars are directed to open and close the switches so as to leave them in proper order. Any person who shall refuse or neglect to comply with the provisions of this regulation shall, for every offense, forfeit and pay the sum of ten dollars."

It must have been a very interesting and novel sight, indeed, when the horse and the locomotive were used indiscriminately on the same track and were struggling for supremacy as the future motive power of our railroads, and the approacn of a locomotive was heralded by the tooting of a horn. Even at that time the right of way was given to the fast horse.

* * *

What is said to be the largest and most powerful towboat ever built for the Mississippi River was recently constructed at Dubuque, Iowa, to the order of the Monongahela River Consolidated Coal and Coke Company, Pittsburg, for use in taking down river the immense fleets of coal barges. She is the usual stern-wheel type of steamer which predominates on the Western rivers, but in size is very much larger than any boats yet built, her "over all" length being 318 feet. The hull is built of steel from the boiler deck down, the general dimensions being as follows: Length of deck, 277 feet; beam, 61 feet; depth, 7 feet. To give sufficient strength to this long and very shallow vessel 3 fore-and-aft bulkheads are fitted, and a system of chains and braces, similar to the hog frame in side-wheel steamers, is built to take up the strains due to the heavy weights resulting from placing the boilers forward and the engines aft.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY
DESIGN—CONSTRUCTION—OPERATION.
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
66 WEST BROADWAY, NEW YORK CITY.
CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1903.

NET CIRCULATION FOR OCTOBER, 1903,—25,769 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 or more reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 or more reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

The growth of the oil industry in the United States has developed a highly skilled class of operators known as drillers, who are able to rapidly and cheaply sink bore-holes into the earth to depths of 1,000 to 2,000 feet, and more. But in these operations it is rare that a bit as large as 12 inches is used; the usual size being under 8 inches diameter. What then would the average driller think of sinking a shaft 9 feet diameter by the jump-drill operation? It would certainly be regarded as a big contract by most of them. At the present time, however, a colliery shaft is being sunk at Dover, England, by the Kind-Chaudron system which uses a special cutting tool called a "trepan" attached to a very heavy walking-beam by pitch-pine rods. The trepan is 9 feet across the cutting edge, which consists of 19 steel bits in line, each weighing over 100 pounds. This process has been used in Continental countries for some years in sinking mine shafts through ground in which extensive water strata is met with, but beneath which an impervious stratum will be encountered. When this strata has been reached by the "trepanning" operation the shaft is lined or "tubbed" with heavy iron rings tightly packed at the lower end by a "moss-box" to exclude the water.

* * *

The three-cornered muddle over the contracts to be let for the new battleships, in which the Bethlehem, Carnegie, and Midvale Steel companies are participating, promises to introduce a new point in law that is of considerable interest to manufacturers. The Bethlehem and Carnegie companies both have large and complete plants for producing armor plate by the Krupp process, and these two companies claim to control the rights for the use of this process in the United States, and exact a royalty from the government on the plate made at government plants. The Midvale company have not yet completed their plant for the manufacture of armor plate, and it is not known what process they intend to use; but it is surmised that it will be the Krupp process, also. The Bethlehem and Carnegie companies not only claim that the Midvale company will not be able to complete its contract, if it secures it, within the time specified, but further assert that they will compel the government to pay royalties on all the plate furnished by the Midvale company, inasmuch as it will infringe on the rights to the Krupp process, which the former concerns control. The peculiar part of the situation is, however, that there is no patent on the Krupp process, and that propriety rights with regard to it are held solely in virtue of its being a secret process and one that has been developed at great cost and has required the establishment of immense plants for its production. Will the courts decide that there is property in a secret process, even after it has been discovered by other persons and put to use by them? Apparently there is a new point of law involved which it has heretofore been supposed did not exist—and probably would not exist except for the millions of vested interests involved in the equipment of the plants. It remains for the courts to say, however, that this makes the tenure of the process itself any the more secure.

* * *

ONE WAY TO KEEP UP THE DEMAND.

Not long ago a prominent manufacturer and inventor of special machinery was relating his experiences and cited a certain product which he had developed some 20 years ago and was ready to put on the market. The product was for machine shop use, and inasmuch as the publication of its name would at once indicate at least one of the principals in the incident to be mentioned, it will answer our purpose to call this particular product a new brand of hack-saw blades, which, however, it was not.

The blades which this gentleman produced had remarkable qualities, particularly in the matter of durability. This was obtained in part by using a superior quality of steel, but mainly by the method of manufacture, which involved a forging process, by means of a special machine built for the purpose. The process gave to the steel a peculiar density and toughness previous to its being converted into saw blades, and it was found upon repeated tests that a blade produced by this means would outwear any four blades as usually made. The invention also included methods for nicking the teeth and finishing the blades, which reduced the cost of production to such an extent that blades could be manufactured by the new method at considerably less cost than any other blades had ever been produced for.

Now, Jones & Co. were the largest manufacturers of hack-saw blades in the country; so large, in fact, that they practically supplied the trade and had all they could do to keep up with their orders. They in some way heard of the work of the inventor and made overtures for the purchase of the invention. The inventor stipulated that if it were disposed of, the sale must be effected without the purchaser seeing the machine, or any of the apparatus; that cash must be paid; and that on his part he would guarantee the method to be all he claimed for it and the machine to be well constructed and free from trappy features. He furthermore agreed that in case the machine would not do what was claimed for it, he would refund the money, the question of refunding to be decided by a committee selected from the employees of Jones & Co., the prospective purchasers. Although these conditions were very unusual, the invention was apparently so valuable that the price of $25,000 was paid outright, and there never was a question raised as to the refunding of the money.

This sale, however, was the end of the invention, and it never after saw the light of day. Jones & Co. believed that if saw blades were put on the market which would outwear four times as many blades of their own manufacture, there would then not be as many people to buy saw blades, and that their production would be cut down to so great an extent as to be ruinous to their business. Although the new blades could be made cheaper and sold for a lower figure, or at the same figure at a greater profit, they still thought it to their interest to shelve the invention and so compel people to use blades of inferior quality and buy more of them.

There have been many firms who have held to the same mistaken and ancient views as Jones & Co., but fortunate it is that they have not been in the majority. It was perfectly natural that this company should have desired to control the best processes for making hack-saw blades, and should have purchased the invention of our friend; but if they had also made an effort to produce the best article that could be made, and had put it on the market at a fair price, they would have been more in line with present-day practice, for the best foundation for any business is the reputation for the best goods at a fair price.

Dr. Th. Goldschmidt, the well-known German chemist and discoverer of thermit, will give a lecture on this compound and make a demonstration of the thermit welding process at Columbia University some time during the second week in November. Further information may be obtained from Mr. Ernest Stutz at the Murray Hill Hotel, New York.

Gordon McKay, the millionaire inventor of shoe machinery, died on October 19. McKay was born in Pittsfield, Mass., and when a small boy showed a talent for mechanics. His first employment was with the Lowell (Mass.) Machine Company, where he helped in building the first locomotives for the Boston & Maine Railroad. Early in his life he became associated with L. R Blake, of Arbington, Mass., who invented a shoe-sewing machine, which eventually proved a failure. McKay saw its possibilities, however, and bought the patent rights. Then he inserted the necessary improvements and began to make his millions. He later invented a heeler, lasting machine, and shoe-nailing machine, and through the use of these was the only manufacturer in a position to offer to make shoes for the Union Army. The fortune that he amassed can only be estimated. At one time he was receiving a commission of from ½ to 4 cents on every shoe manufactured with the aid of his inventions, from Maine to California, in addition to enormous royalties from his British patents. Harvard University will now receive $4,000,000 of McKay's fortune, which was placed in a trust fund for the university in 1893, but at the time of his death it was not known to whom the balance, and probably the greater part of his fortune, would go.

THE DATA SHEET FOR THE CURRENT ISSUE.

The tables comprising the data sheet for this month have been furnished us by the Garry Iron and Steel Co., Cleveland, Ohio, and represent the practice followed in their engineering department for the design of round shafting. They consist of diagrams by means of which may be solved graphically the formulas for round shafts when subjected to twisting moments, bending moments, or to a combination of both twisting and bending moments.

Table 1 is calculated on the formula $T = \frac{Sd^3}{5.1}$, and consequently for a given twisting moment, T, the diameter of the shaft $d = \sqrt[3]{\frac{5.1\ T}{S}}$. In this formula S represents the fiber strain per square inch and the diagram is arranged for values of S from 4,000 to 24,000 pounds per square inch.

Table 2 is arranged to give the diameter of shafts subjected to bending moments. The formula for shafts loaded in this manner is $M = \frac{S\ d^3}{10.2}$ giving a value for the diameter $d = \sqrt[3]{\frac{10.2\ M}{S}}$. In the diagram seven values of S are given, ranging from 5,000 to 30,000 pounds per square inch.

Table 3 is used for determining the size of shafts that are subjected to a combined twisting and bending moment. Upon the horizontal base are denoted the twisting moments and upon the vertical side the bending moments. By following vertically and horizontally the respective lines representing the given moments, their point of intersection will fall upon a line which represents the diameter of a shaft of suitable size to sustain the combined load. This diagram is calculated by the well-known formula:

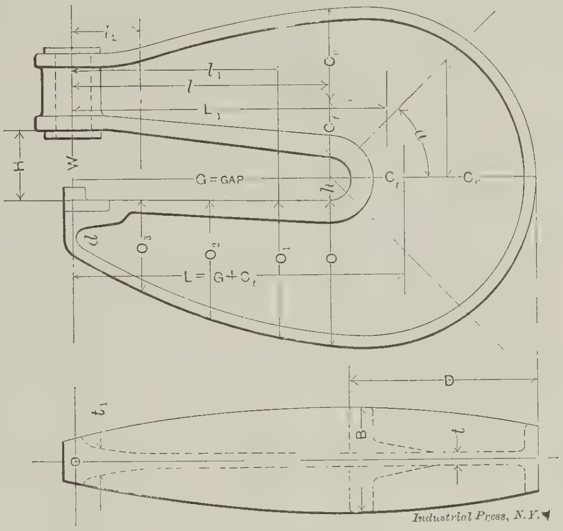
Combined moment $= M + \sqrt{M^2 + T^2}$
in which $M =$ bending moment,
$T =$ twisting moment.

The results of this diagram are based on a tensile strength of 7,500, and a shearing strength of 6,000 pounds per square inch. If we desire to find the diameter for any other tensile strength we first find it from Fig. 3 and then, by referring to Fig. 4, find a new diameter for any desired fiber strain from 5,000 to 30,000 pounds per square inch.

DESIGN OF PUNCH AND RIVETER FRAMES.

JOHN S. MYERS.

In the design of a punch, riveter or shear frame the depth of throat or gap G, and the height of the throat H and h, Fig. 1, are determined by the size and character of the work to be done. In riveters the stake is usually fixed by the smallest shell that is to be riveted, and dimension O must consequently be less than the internal diameter of this shell. It is customary, when thus limited, to make the section of the stake as shown in Fig. 2 in order to obtain as deep a section as possible. The strength of similar sections varies as the cube of the depth while the area varies as the square of the depth, so that ordinarily, a deep section is more economic of material than a shallow one. If, however, the depth D is great in proportion to the gap G, as shown in Fig. 3, the length of the compression flange is increased to such an extent that the entire frame is heavier than it would be if a shallower section were used. A machine of one hundred and eighty tons capacity, having a gap G of 9¼ inches was found, when made of steel castings, to be considerably lighter with a depth D of 16½ inches than when this depth was made 22 inches.



Industrial Press, N.Y.

Fig. 1

In riveters of long gap the spring or deflection is an important factor. This varies as the cube of the length and inversely as the moment of inertia of the section. For similar sections the moment of inertia varies as the fourth power of the depth; hence the adaptability in riveters of deep gap of the form of section shown in Fig. 2, keeping the depth of section as great as is consistent with the work to be done.

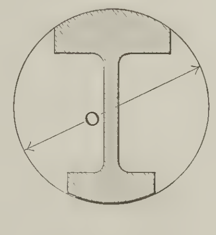
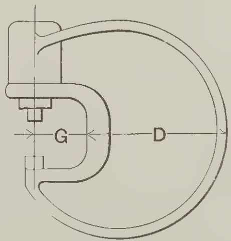


Fig. 2.



Industrial Press, N.Y.

Fig. 3.

In designing punches and shears, the dimensions O, D, B and t are selected according to the judgment of the designer. The frames are usually made of cast-iron as a more rigid frame can thus be produced for less money than if it were made of steel. If it is portable, however, weight becomes the main factor and steel may then be used advantageously. The thickness of the web t is mostly a consideration of what will cast well and for this reason it should be thickened where it joins the heavy tension flange at the end of the throat. This thickening also takes care of the rapid transition of stresses that takes place at this point. At t_1, Fig. 1, it should usually be thickened to carry the shear, as little of the shear is carried by the flanges, and the web is shallow at this point.

In punching large holes in thin plates with a flat-ended punch, the plate gives way at a certain point with a snap. If the head of the machine is heavy and the spring considerable, the kick, due to inertia, reverses the stresses when the plate gives way, suddenly releasing the frame. While this would probably never be enough to endanger the compression flange, yet the reversal of stresses weakens the tension flange.

After having decided upon the material to be used and the allowable stresses in tension, compression and shear, the usual method is to assume the proportions of the main section and calculate for the stress. If the results are not reasonably near the chosen ones, correct the first assumptions and recalculate.

The frame is acted upon by a force *W*, which produces a bending moment equal to the force times the length of the lever arm. On the main section the lever arm is the perpendicular distance from the line of action of the force *W* to the center of gravity of the section, and equals $G + Ct$, Fig. 1.

Let:

L, L_1, l, l_1, l_2, etc = lengths of lever arms, in inches, to various sections.

Ct and *Cc* = distance from center of gravity of section under consideration to extreme fiber of tension and compression flanges respectively.

W = Force, in pounds, applied at the die. (If a hydraulic machine, this is taken equal to the effective area of the ram multiplied by the working pressure per square inch.)

S = Uniformly distributed tensile stress due to force *W*.

Ss = Shearing stress carried mainly by the web of section.

St = Tensile stress due to moment of force *W*.

Sc = Compressive stress due to moment of force *W*.

Smt = Maximum or combined tensile stress.

Smc = Maximum or combined compressive stress.

A = Area of section under consideration.

I = Moment of inertia of section.

M = Bending moment, in inch pounds.

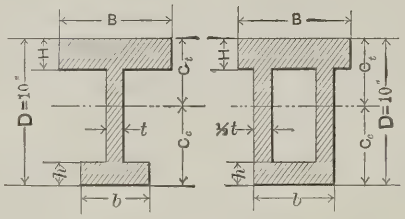
a = Angle of section with center line of frame.

Then:

$M = WL, WL_1, Wl, Wl_1, Wl_2$, etc.

$$S = \frac{W \cos a}{A}$$

TABLE OF THE ELEMENTS OF CAST SECTIONS.

Section Number.	 B B H H D=10" D=10" t ½t Ct Ct Cc Cc h h b b							Area in square inches.	Moment of Inertia.	Section Modulus for Tension.	Section Modulus for Compression.	Original Depth.	Original Material.	Location of Section.	Load at Die in pounds.	Distance from Die.	Bending Moment in inch pounds at Section.	Maximum Tensile Stress.	Maximum Compressive Stress.
	B	H	b	h	t	Ct	Cc	A	I	$\frac{I}{Ct}$	$\frac{I}{Cc}$	D	m		W	l	M	Smt	Smc
1	6.67	1.39	2.23	.694	.556	2.95	7.05	15.2	166	56.4	23.6	18	C. I.	Per	27,50	10.5	435,000	1,880	2,600
2	5.56	1.53	1.67	.830	.560	2.98	7.02	14.0	148	49.8	21.1	18	S. C.	Per	250,000	5.63	2,750,000	14,940	16,790
3	4.00	1.63	1.50	1.00	.625	3.04	6.96	10.1	141	46.2	20.2	20	...	..	....	....	......	....	....
4	5.00	1.13	1.50	.750	.500	3.09	6.91	11.4	129	41.6	18.6	20	...	..	....	....	......	....	....
5	5.56	1.67	1.95	1.110	.560	3.20	6.80	15.4	173	54.1	25.5	9	N. S.	Per	100,000	3.5	637,000	24,140	26,400
6	5.50	1.50	2.00	1.00	.500	3.21	6.79	14.0	164	51.2	24.2	10	...	..	....	....	......	....	....
7	5.00	1.14	1.82	.680	.450	3.25	6.75	10.6	128	39.3	18.9	11	...	..	....	....	......	....	....
8	5.56	1.25	1.67	.833	.560	3.25	6.75	12.7	145	44.5	21.4	18	...	..	....	....	......	....	....
9	4.89	1.56	2.67	.667	.444	3.26	6.74	12.8	155	47.7	23.1	45	...	..	....	....	......	....	....
10	5.00	1.43	2.14	.714	.540	3.30	6.70	12.9	150	45.5	22.4	7	...	..	....	....	......	....	....
11	8.90	1.48	3.70	.987	.740	3.33	6.67	22.4	298	89.6	44.8	10	...	..	....	....	......	....	....
12	10.00	.833	5.00	.833	.833	3.33	6.67	17.4	212	63.6	31.8	10	...	..	....	....	......	....	....
13	4.55	1.82	2.27	.910	.570	3.45	6.55	14.5	167	48.4	25.5	22	S. C.	Per	360,000	9.2	6,048,000	16,870	17,060
14	6.67	1.67	3.00	1.17	.667	3.48	6.52	19.4	240	68.8	36.7	15	...	..	....	....	......	....	....
15	5.72	1.43	2.14	1.07	.710	3.50	6.50	15.8	187	53.5	28.8	7	N. S.	Per	57,700	2.5	285,600	23,030	21.500
16	4.89	1.22	2.67	.667	.444	3.51	6.49	11.4	150	42.6	23.0	45	S. C.	Per	300,000	50.	19,737,000	6,390	8,120
17	3.75	1.81	2.08	.555	.694	3.55	6.45	13.2	142	40.0	22.1	72	C. I.	Per	381,600	60.	32.665 000	2,750	3,410
18	4.89	1.17	2.67	.667	.444	3.56	6.44	11.1	148	41.6	23.0	45	S. C.	Per	300,000	50.	19,505,000	6,560	8,120
19	5.00	2.03	2.81	1.25	.470	3.57	6.43	16.8	211	59.0	32.8	16	S. C.	Per	200,000	8.1	2,760,000	16,050	15,870
20	4.89	1.11	2.67	.667	.444	3.62	6.38	10.9	154	42.7	24.1	45	S. C	Per	300.000	50.	19,880,000	6,740	8,140
21	5.00	2.19	2.81	1.25	.625	3.63	6.37	18.6	220	60.5	34.5	16	S. C.	Per	200,000	8.1	2,782,000	15,330	15,475
22	4.89	1.06	2.89	.611	.444	3.69	6.31	10.6	146	39.6	23.2	45	S. C	Per	300,000	50.	19,980,000	6,910	8,060
23	5.00	1.01	2.86	.595	.476	3.71	6.29	10.8	146	39.3	23.2	42	S. C.	Per	300,000	50.	19,670,000	8,330	9,880
24	7.28	3.64	4.24	1.82	.910	3.73	6.27	38.3	376	101.0	60.0	16½	S. C.	Per	360,000	9.25	5,540,000	15,700	17,300
25	5.00	2.00	3.00	1.25	.625	3.75	6.25	18.0	226	60.1	36.1	20	S. C.	45°	360,000	8.93	5.130,000	14,200	14,300
26	7.50	3.44	4.38	1.88	.940	3.76	6.24	38.4	398	106.0	63.8	16	S. C.	45°	360,000	9.00	4,770,000	13,600	15,700
27	5.00	1.88	3.25	1.25	.438	3.81	6.19	16.5	222	58.2	35.8	16	S. C.	Per	200,000	8.00	2,840,000	16,678	14,654
28	5.00	1.43	3.93	.536	.714	3.78	6.22	15.0	190	50.3	30.5	56	C. I	Per	200,000	50.	14,240,000	2,040	2,230
29	3.69	1.85	2.61	.597	.761	3.81	6.19	14.2	182	47.8	29.4	46	C. I.	Per	199,050	28.	9,070,000	2,620	2,520
30	5.00	1.07	2.86	.710	.540	3.84	6.16	12.1	160	41.7	26.0	7	...	..	....	....	......	....	...
31	6.10	1.95	5.36	.732	.976	3.90	6.10	23.0	288	73.7	47.2	41	C. I	Par	200,000	32.	6,400,000	1,260	1,970
32	6.67	1.50	4.00	1.17	.670	3.92	6.08	19.6	273	69.5	44.8	15	...	..	....	....	......	....	...
33	6.67	1.67	4.00	1.33	.670	3.94	6.06	21.1	295	74.7	48.6	7½	...	..	....	....	......	....	....
34	6.90	1.55	3.45	1.55	.862	3.96	6.04	22.0	286	72.2	47.4	$5\frac{8}{10}$	N. S.	45°	57.700	2.45	235,000	21,510	18,840
35	3.75	1.25	2.50	.729	.521	3.97	6.03	8.6	141	35.5	23.4	48	S. C.	Per	100,000	100.	11,907,000	3,440	5 000
36	10.00	4.17	5.84	2.71	1.25	4.01	5.99	61.4	578	144.0	96.4	12	S. C	Par	360,000	8.1	2,916,000	11,700	17,500
37	6.82	1.82	4.85	1.21	1.21	4.17	5.83	26.8	387	92.8	66.4	33	C. I.	Par	200,000	18.	6,350,000	2,590	1,983
38	5.56	1.11	4.08	.926	.56	4.30	5.70	14.4	216	50.3	37.9	27	S. C.	Per	200,000	50.	12,400,000	14,580	14,600
39	6.28	1.00	4.57	.857	.571	4.32	5.68	14.86	229	53.0	40.3	35	...	...	....	....	..	....	....
40	7.14	2.50	5.00	2.35	.890	4.36	5.64	34.1	434	99.4	76.8	14	S. C.	Par	360,000	8.5	3,060,000	11,200	14,580
41	6.00	1.10	4.50	1.00	.600	4.44	5.56	15.8	242	54.5	43.5	25	S. C.	45°	200,000	48.7	11,600,000	14,030	16,070
42	6.28	1.00	5.00	.857	.571	4.45	5.55	15.2	239	53.7	43.1	35	S. C.	Par	300,000	47.	14,100,000	6,110	7,530
43	6.74	1.12	5.40	1.12	.670	4.63	5.37	18.9	294	63.5	54.8	22¼	S. C.	Par	200,000	48.	9,600,000	14,000	15,700
44	6.76	1.22	5.68	1.22	.810	4.70	5.30	21.3	321	68.2	60.5	18½	S. C.	Par	200,000	30.	6,000,000	13,900	15.650
45	3.33	.93	2.96	.925	.370	4.82	5.18	8.9	137	28.4	26.5	54	S. C.	Par	....	....	52,432.000	11,740	12.600
46	3.33	.98	2.94	.980	.392	4.82	5.18	9.3	142	29.5	27.4	51	S. C.	Par	....	....	43,975,000	11,200	12,100
47	8.33	1.67	7.50	1.67	1.25	4.84	5.16	34.7	595	123.0	115.0	12	S. C.	Par	200.000	12.	2,400,000	11,300	12,100
48	10.53	1.97	10.53	1.97	1.32	5.00	5.00	49.5	707	141.0	141.0	$3\frac{8}{10}$	N. S.	Par	57,700	2.2	126,900	16,350	16,350
49	3.63	1.14	3.63	1.14	.795	5.00	5.00	12.1	194	38.8	38.8	44	S. C.	Par	....	....	33,000,000	10,000	10,000
50	3.63	1.14	3.63	1.14	.91	5.00	5.00	15.3	198	39.6	39.6	44	S. C.	Par	....	....	33,000,000	9,770	9,770

for main section, where $a = o$; $S = \dfrac{W}{A}$

$$Ss = \frac{W}{\text{area of web}}$$

$$St = \frac{M\,Ct}{I}$$

$$Sc = \frac{M\,Cc}{I}$$

$$Smt = St + S$$

$$Smc = Sc - S$$

The dimensions of the main section being assumed, to determine the center of gravity and moment of inertia: Take the moments of the different areas of the section about some line of reference and divide the algebraic sum of the moments by the total area, which gives the distance of the center of gravity from this line. The neutral axis passes through the center of gravity of the section. The moment of inertia is equal to the sum of the product of each area by the square of its distance from the neutral axis, plus its moment of inertia about its own neutral axis.

As an example, we will consider the design of a 150-ton punch frame, which is to be quite rigid, but as light as consistent with good design; being mounted upon a carriage, gap to reach the center of an 8-foot plate. We will make this frame of a steel casting, of I-section, quite deep, and with medium stresses to insure rigidity. Then

W = 300,000 pounds, and assume:
Smt = 6,000 pounds per square inch.
Smc = 8,000 pounds per square inch.

For main section, referring to Fig. 4:

$$\begin{array}{lll}
5\tfrac{1}{2} \times 22 = 121 \text{ sq. ins.} \times 21 & = & +\ 2541 \\
2 \times 36\tfrac{1}{2} = 73 \text{ sq. ins.} \times 0 & = & 00 \\
3 \times 12 = 36 \text{ sq. ins.} \times 19.75 & = & -\ 711 \\
\hline
A = 230 \text{ sq. ins.} & & \dfrac{1830}{230} = 7.96
\end{array}$$

$$121 \times 13.04^2 + \frac{22 \times 5.5^3}{12} = \begin{cases} 20,600 \\ 304 \end{cases}$$

$$73 \times 7.96^2 + \frac{2 \times 36.5^3}{12} = \begin{cases} 4,616 \\ 8,100 \end{cases}$$

$$36 \times 27.71^2 + \frac{12 \times 3^3}{12} = \begin{cases} 27,600 \\ 27 \end{cases}$$

Moment of inertia, I = 61,247

$L = G + Ct = 50 + 15.79 = 65.79$

$M = WL = 300,000 \times 65.79 =$ 19,737,000 inch pounds.

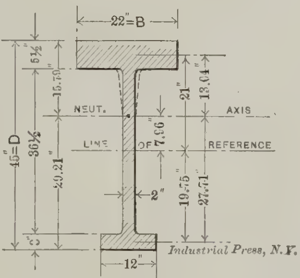


Fig. 4.

$$S = \frac{W}{A} = \frac{300,000}{230} = 1,305$$

$$St = \frac{M\,Ct}{I} = \frac{19,737,000 \times 15.79}{61,247} = 5,085$$

$Smt = S + St = 5,085 + 1,305 = 6,390$

$$Sc = \frac{M\,Cc}{I} = \frac{19,737,000 \times 29.21}{61,247} = 9,420$$

$Smc = Sc - S = 9,420 - 1,305 = 8,115$

These stresses are, therefore, found to be sufficiently near to those which were assumed.

The vertical section is figured likewise, except that there is no direct tension S to combine, but the shear on the web. The section at an angle a has $S = \dfrac{W \times \cos a}{A}$ to combine. The moment on this section is $M = W L_1$. The vertical section having been determined, the others may be proportioned from it thus: $l : l_1 :: O^3 : O_1^3$, or $O_1 = \sqrt[3]{\dfrac{l_1 O^3}{l}}$ and all of the other dimensions in like proportion.

Calculate the ordinates O_1, O_2, O_3, etc., and lay them out. The curve found will not be a very pleasing one, and will have to be varied somewhat. Keep the web of a uniform thickness, and taper the flanges in straight lines, keeping the area of the flanges the same as if proportioned from the above formula. Check two or three sections for St and Sc by finding center of gravity and moment of inertia, by method given above. Allow a somewhat lower stress on tension flange of the 45 deg. section and use large fillets for steel.

It is very often the case that two or more sections have to be calculated before the proper sizes are determined, and this becomes a tedious job. In the table herewith are given the elements of fifty different sections reduced to a uniform depth of 10 inches, showing their relative proportions, from which sections may be proportioned to suit almost any condition. From our known values, M, St, and Sc, we get $\dfrac{M}{St} = \dfrac{I}{Ct}$ and $\dfrac{M}{Sc} = \dfrac{I}{Cc}$. From the columns headed $\dfrac{I}{Ct}$ and $\dfrac{I}{Cc}$, we get the value of these quantities for the chosen section at a depth of 10 inches and our new depth will then be 10 times the cube root of the required value, divided by the tabulated value. The depth being determined, all of the other dimensions can be readily figured by direct proportion. If the required depth were 25¼ inches, multiply all of the dimensions in the table by $\dfrac{25.25}{10} = 2.525$.

Remembering that the dimensions vary as the depth, the area as the square of the depth, the sectional modulus as the cube of the depth, and the moment of inertia as the fourth power of the depth, any of these elements can be readily obtained.

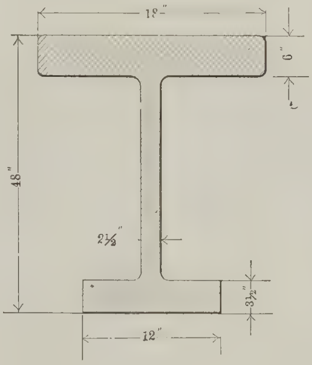


Fig. 5.

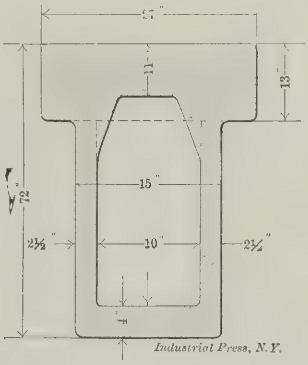


Fig. 6.

The section figured above as an example is No. 16 in the table. No. 35 was originally 48 inches deep. $B = 4.8 \times 3.75 = 18$ inches. $H = 4.8 \times 1.25 = 6$ inches. $b = 4.8 \times 2.5 = 12$ inches. $h = 4.8 \times .729 = 3\tfrac{1}{2}$ inches. $t = 4.8 \times .521 = 2\tfrac{1}{2}$ inches. All as shown in Fig. 5. This was the main section of a 100-inch, 50-ton riveter. The maximum stresses are given in the table.

Fig. 6 shows section No. 17 as it was originally built. It was for the main section of a 60-inch gap shear having an 18-inch ram at a working pressure of 1,500 pounds per square inch. The section was calculated as if the tension flange were 27 x 13 inches, the small amount of metal cut out being assumed to be replaced by the thickening up of the side web plates in front.

Sections Nos. 37 and 38 were main sections of an 18-inch 100-ton punch and a 50-inch, 100-ton punch, respectively. No. 45 was a beam 15 feet 6 inches long, carrying a uniformly distributed load of 1,130 tons. In the column headed "location of section," Par. means that the plane on which the section was taken is parallel to the direction of the force at the die; Per. similarly means perpendicular to the direction of this force.

* * *

Another use for cement construction is for curtain walls of expanded metal and cement or plaster to prevent the rapid spread of flame. At the Deering Harvester Plant, Hamilton, Ont., the roof trusses are lathed on both sides with expanded metal, the wall being carried up three feet above the roof, and the laths then covered with one inch of cement mortar.

THE NEWPORT (R. I.) STEAM TURBINE STATION

The first vertical Curtis steam turbine to be installed in this country is a 500 K. W. machine, at Newport, R. I. In the March, 1903, number of the Engineering Edition was a brief description of the Newport plant, with a line-drawing, showing the arrangement of the machinery in the engine room. We are now able to show two illustrations from photographs of this plant, together with detail drawings of the Schmidt independent superheater, with which the plant is equipped. This superheater is of unusual interest, as the work done by William Schmidt in the use of superheated steam in Germany has attracted the attention of engineers all over the world. The superheater of this design is now made in this country by the Providence Engineering Works, who control the patent rights for the United States, and installed the apparatus at the Newport station.

The Newport station is one of several controlled by the Massachusetts Electric Companies, who operate about 900 miles of electric street railways and have already contracted for 33,000 horse power in steam turbines. Three of these are 500 K. W. machines, and will be installed at Newport, while the others will be placed in stations at Fall River and Quincy Point, Mass., and will be much larger units.

The Newport turbine, at present in operation, runs at 1,800 revolutions per minute, taking steam at 140 pounds pressure at the turbine nozzles. Alternating current of 2,500 volts is generated. The turbine is 7 feet 8 inches in diameter at the base, and 12 feet 6 inches high. The station plans call for four turbines in all. The boiler room is equipped with the Schmidt superheater, which may be used or not at will, the intention being to carefully experiment and note the action of the turbines with both saturated and superheated steam. Four 350 horse power Aultman & Taylor water-tube boilers, fitted with Green economizers, will be installed at first. The separately fired superheater stands at one end of the line of boilers, and the arrangement of the steam piping is such that steam can be taken through the superheater or direct from the boilers.

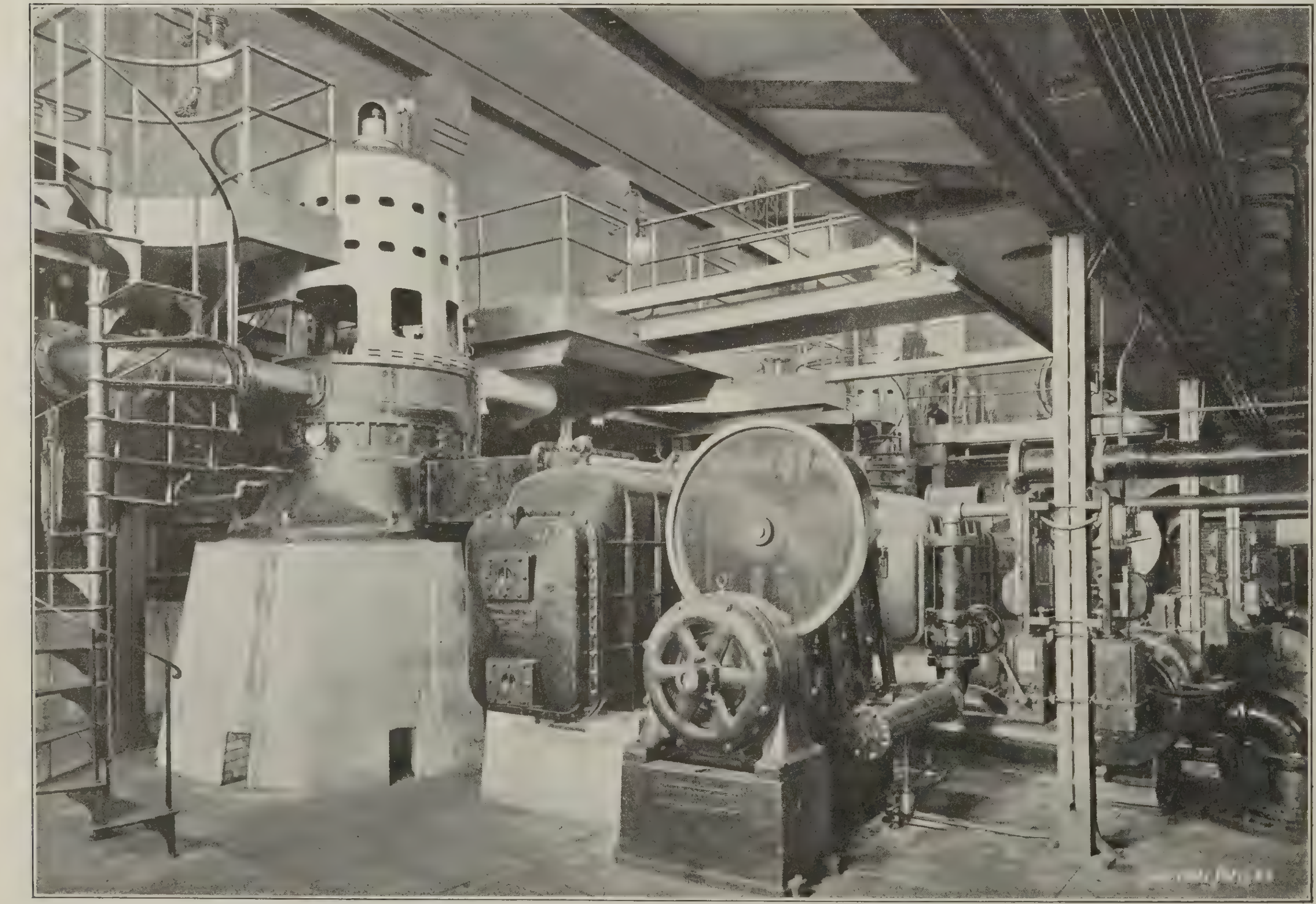


Fig. 1. The New Steam Turbine Station at Newport, R. I.

It will be noted in the illustrations that the engine room floor level is above the turbine proper, the generator only being above the floor. A heavy foundation of brick is provided for each unit, the dimensions being 9 feet square at the top, 11 feet at the bottom, and 5½ feet high. Beneath this is an 18-inch bed of concrete.

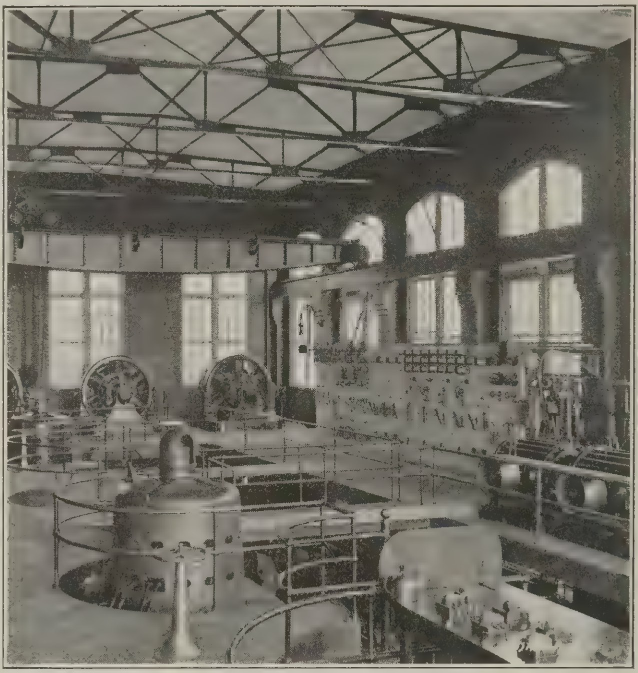


Fig. 2. View of Gallery in Power Station.

In explanation of the drawing of the superheater, saturated steam enters through the inlet valve, *A*, and passes through the cast-iron cross pipe, *B*, at the top of the superheater, to which the two upper sets of coils are connected. The satu-

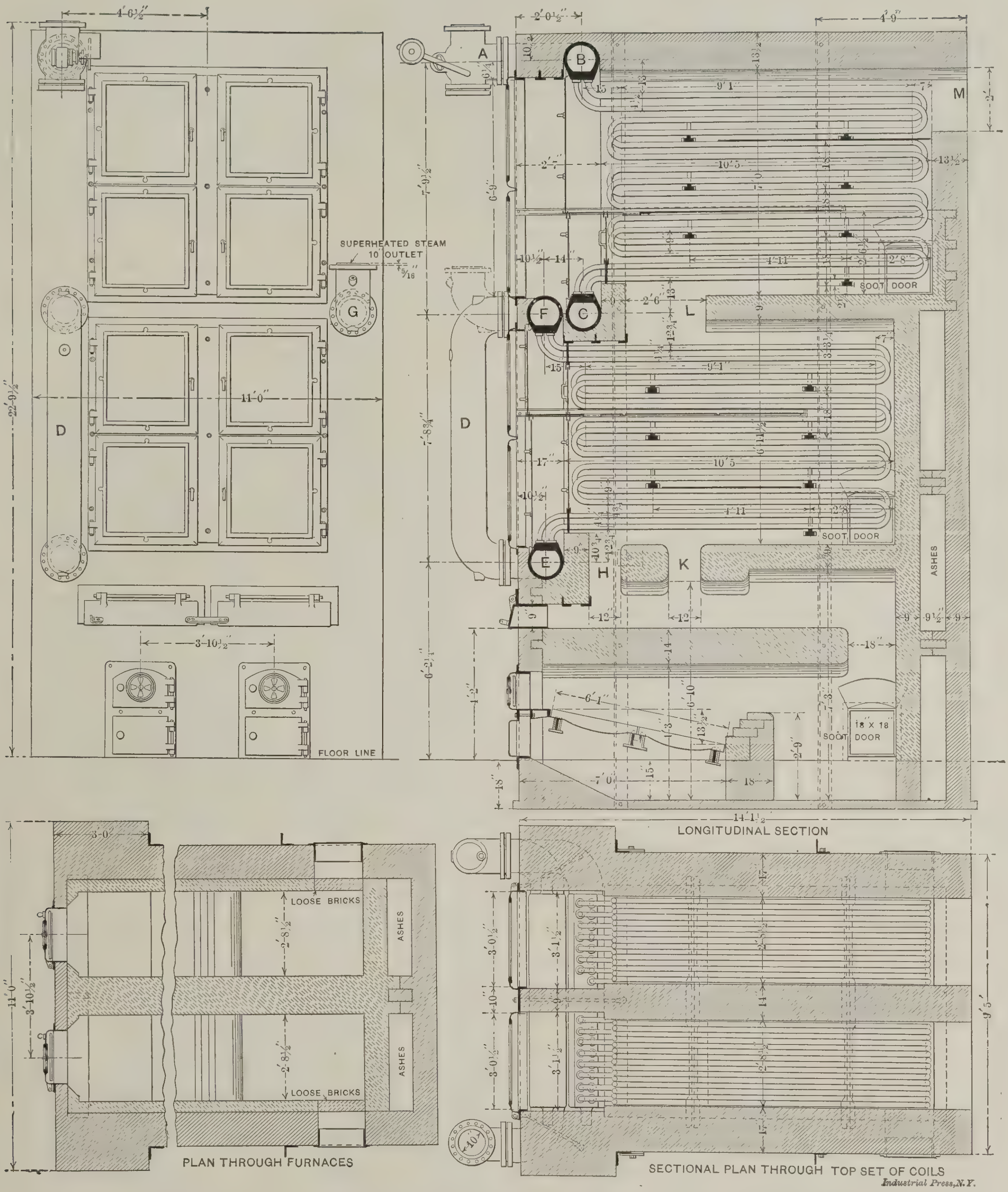


Fig. 3. Details of the Independent-fired Schmidt Superheater at the Newport Station; built by Providence Engineering Works.

rated steam then passes down through these two coils, becoming superheated on the way to the cross pipe, *C*; thence to the pipe, *D*, on the outside of the apparatus, which carries the steam to the bottom of the two lower sets of coils. The steam here enters cross pipe, *E*, and thence passes upward through the lower coils, where it comes in contact with gases at a higher temperature. The superheated steam outlet is at *G*, near the center of the superheater. The object of locating the outlet at this point is to secure as low a temperature of the escaping gases as possible, and at the same time have the heat transmitted to the steam efficiently. This method is a compromise between having steam enter at the top and leave at the bottom, or have it enter at the bottom and leave at the top. The former arrangement would give rather slow interchange of heat and the latter would send the gases up the flue at too high a temperature.

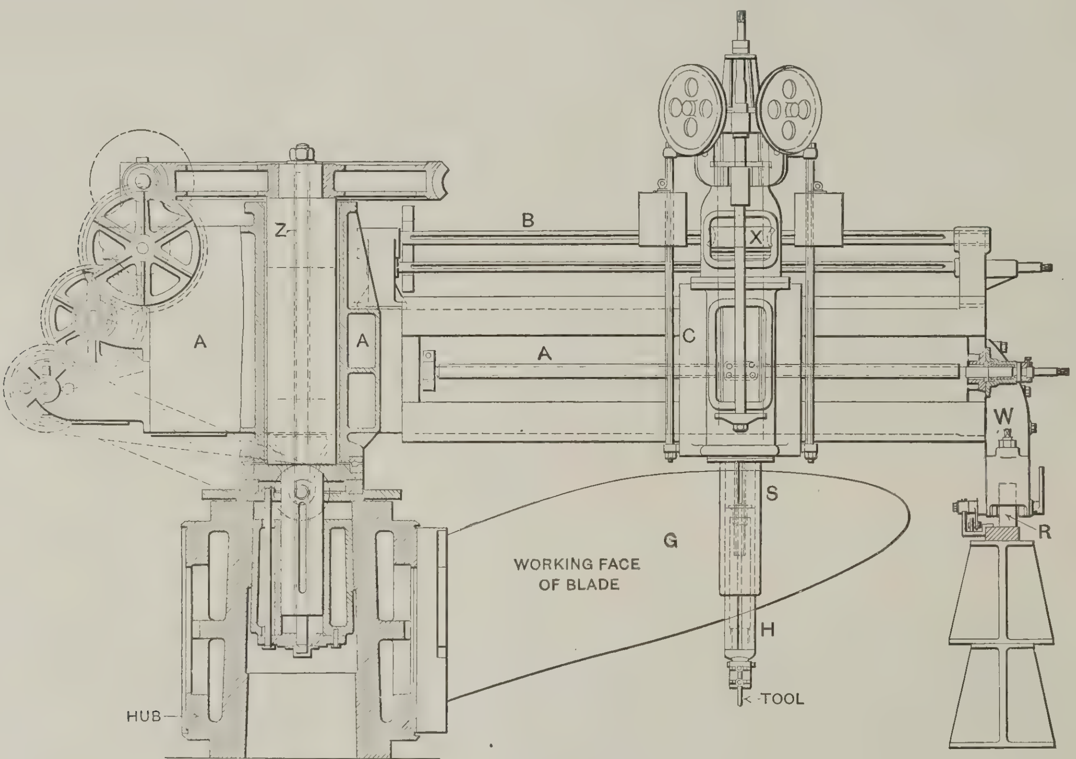
Tests upon this turbine were recently quoted by Mr. A. R. Dodge, in a paper read before the New England Cotton Manufacturers' Association. The tests were run at 140 pounds gage pressure, 250 degrees of superheat, and with the turbine connected to operate condensing. At a load of 500 K. W. the steam consumption was slightly less than 18 pounds per K. W. hour, and it remained nearly constant at this figure for increased loads, up to 800 K. W. At a load of 200 K. W. the consumption was about 20 pounds.

The motors required to operate the circulating and air pumps for the condenser are driven from the turbine generator and this power, about 20 K. W., is included in the output of the machine. Analysis of the velocities obtained indicate that this result from the first vertical unit will be materially reduced. Lighting, railway, and arc load are all carried on the same unit without difficulty.

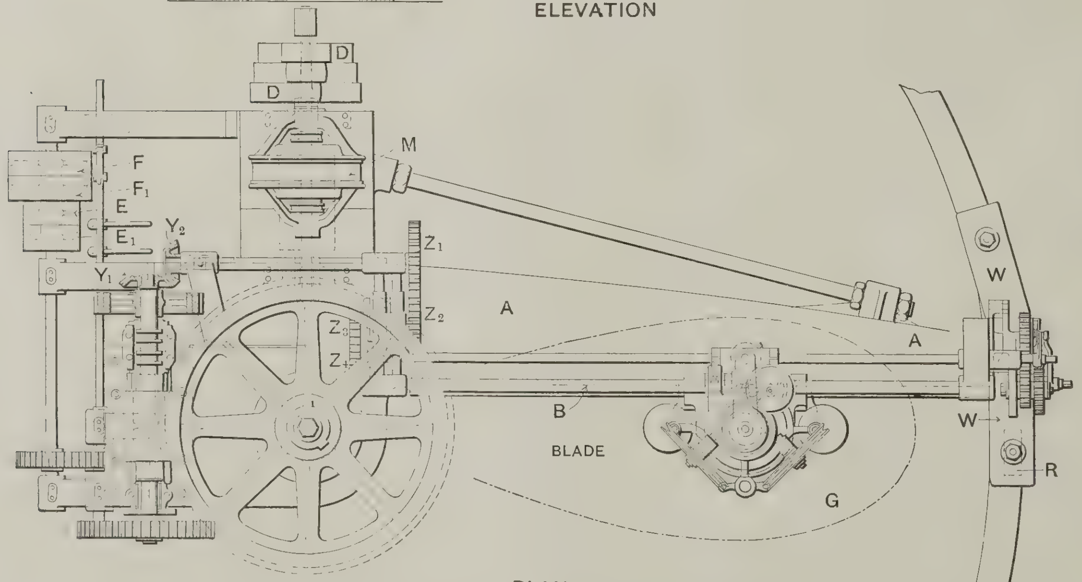
BAUER PROPELLER-BLADE SHAPING MACHINE.*

The propeller blades of the *Kronprinz Wilhelm* and the *Kaiser Wilhelm II.*, of the North German Lloyd Steamship Company, were shaped to the theoretically correct working face by a shaping machine invented by Dr. G. Bauer, and constructed by the Stettiner Maschinenbau Actien-Gesellschaft, Stettin, Germany, of which concern Dr. Bauer is the chief engineer. The importance of accurately shaped propeller blades has long been recognized, but up to the inception of this machine there has been no means for producing a more accurate surface on large propellers than can be obtained by casting. As an illustration of the need for an accurate shaping machine, a diagram of a propeller blade of the *Kaiser Wilhelm II.* was shown (not reproduced), the inequalities being marked plus or minus according as they are above or below the theoretical working face. As an example, two adjacent points about two feet apart, are noted, one of which was something over one-half inch above the theoretical plane, and the other as much below it, making the total inequality over one inch.

The object aimed at is attained in the machine, illustrated in Figs. 1, 2, and 3, by a planing tool which is reciprocated in helical lines over the blade and progressively fed along its radius after the completion of a cutting and return stroke, as in ordinary planer practice. In this manner a correct helical surface is shaped by concentric helical cuts. The method is applicable for shaping propeller blades to any generating lines. The generating line may be at right angles to the axis or inclined to it, as shown by lines *xy* in *A* and *B*, Fig. 4. It may also be a broken line, with different inclinations to its axis in its different portions.



ELEVATION



PLAN

Industrial Press, N.Y.

Figs. 1 and 2. Plan and Elevation of Propeller Shaping Machines.

The half-tone, Fig. 3, shows the machine at work on one of the blades for the *Kaiser Wilhelm II.* The hub is mounted on a cast-iron floor-plate, and the blades are bolted fast in the same manner as they are in actual service, with the working face upward. The stump or pivot, *Z*, Fig. 1 upon which the radial arm, *A*, swings, is fixed in the hub by being bolted to a cone which fits the bore of the hub. The outer end of the heavy arm, *A*, is supported by a carriage *W* provided with two wheels on a guide-path. The rotation of the arm is produced by a worm-wheel, keyed to *Z*, and a worm which is mounted on the arm together with the motor, *M*. The driving mechanism comprises the pulleys, EE_1, FF_1, the step cones, *D*, and the gear trains.

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* This, from "Engineering" (London), is a description of a machine of great interest, and especially at this time, supplementing, as it does, the article upon the propeller planer in the last number.—EDITOR.

The tool, an ordinary planing steel, is, for reasons presently to be explained, not directly mounted on the tool-holder, *S*, but in a sliding piece, *H*. The tool-holder *S*, moves up and down, and is borne by a carriage, *C*, which travels along the radial arm, *A*. In shaping the propeller blades, *G*, the tool describes helical lines, as was already pointed out. Having made one cut, the tool travels back to the starting point of its operating stroke, following the same path. The forward feed is then imparted to the tool, which now makes a fresh cut, is taken back and again advanced, and so on. The operation is therefore the same as in a shaping machine, except that this new machine moves in helical and not in straight lines. This helical motion is produced by the combination of the up-and-down movement with the rotary movement of the arm, and the pitch of the helix depends upon the adjustable ratio of the two velocities. The vertical movement of the tool is obtained with the aid of a helical thread, cut upon the tool-holder, *S*; this thread engages with the worm-wheel, *X*, fixed in the carriage, *C*. The worm-wheel is driven through the intermediation of the shaft, *B*, the toothed wheels, Z_1, Z_2, Z_3, etc., and the bevel wheels, Y_1, Y_2, from the main worm which rotates the arm, *A*. It will thus be clear that the two movements of the tool—the vertical movement of *S* and the rotation of the whole arm, *A*—are independent of each other, and that the ratio of the two velocities can be varied with the help of the change-wheels, Z_1, Z_2, etc. It is in this way that the machine is set for cutting helical surfaces of different pitches. The reversing mechanism of the machine, which returns the tool to the starting point of its stroke, does not differ from the construction usually to be met with in large modern planing machines.

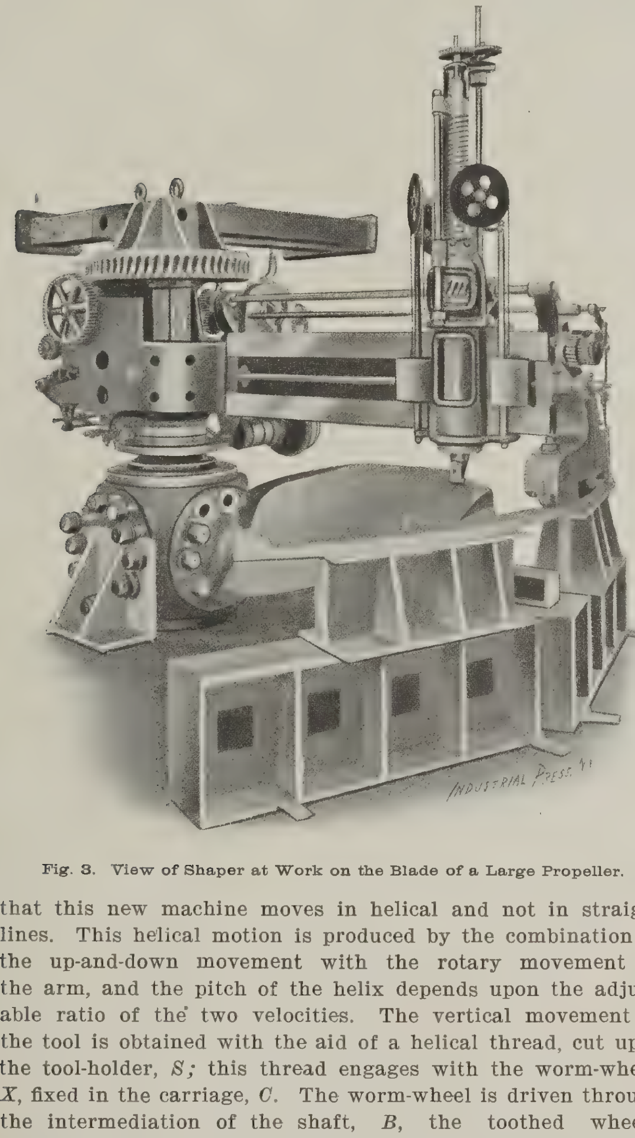


Fig. 3. View of Shaper at Work on the Blade of a Large Propeller.

The feed of the carriage, *C*, along the arm, *A*, is produced by a tappet attached to the guide-path; or what practically amounts to the same thing, the precise construction being a roller attached to the ratchet feed levers, which runs on a stop. For the simple form of propeller in which the generating line is at right angles to the axis, shown at *A*, Fig. 4, the requirements are satisfied by feeding the carriage radially along the arm, *A*, in whatever ratio as determined by the pitch of the propeller. But when the generating line is inclined to the axis as at *B*, Fig. 4, the conditions become slightly more complicated, because it is necessary to provide for axial movement of the tool to correspond to the inclination of the generating line. That is, the axial movement must equal the tangent of the angle made by the generating line with the line at right angles to the axis. In the case of the *Kaiser Wilhelm II.* the diameter of the propeller from tip to tip of the blades is 22 feet 8 inches and the radius is, of course, 11 feet 4 inches. The angle made by the generating line is such that the tips of the blades are separated from the right angle line nearly 26 inches, and it is to compensate for this departure of 26 inches in a radial distance of 11 feet 4 inches, or any other diameter, that the movement about to be described, is introduced.

As already mentioned, the tool is not directly mounted in its tool-holder, *S*, but in the sliding piece, *H*, which can be displaced within the tool-holder by the aid of a screw spindle. In order to ensure the desired inclination between axis and generating line, the proper ratio has to be maintained between the axial and the radial feed. In the case illustrated, the tool is, at the completion of each stroke, raised by the distance, s_1, and advanced outward by the distance, s_2, thus producing a blade surface in accordance with the generating line, *xy*. The spindles for imparting the radial and the axial feeds must be in positive connection, and special gearing is provided for this purpose. The tool itself is an ordinary cutter-bar, whose cutting edge is suitably inclined to the face upon which it works. Since, however, the surface slope diminishes as we approach the top of the blade, it might be thought that the tool would frequently have to be changed during the shaping of one blade. As a matter of fact, however, a blade may almost be completed with one tool, provided the cutting angle be suitably adapted to the average slope of the blade. The tool is, of course, pivoted as in a planing machine, so that it can be deflected during its return stroke, and glide over the blade without meeting any resistance.

The machine represented in the photographic view can deal with screw propellers up to 23 feet in diameter. The pivot, *Z*, about which the arm, *A*, turns, has a diameter of 15¾ inches, and the arm a length of about 13 feet, measured from center to center. When the machine has been mounted in the hub, the height from the upper edge of the bedplate to the upper edge of the worm-wheel is about 10 feet 9 inches; reckoned up to the highest point to which the change-wheels may reach, the height is about 16 feet 6 inches. Complete with bedplate and guides, the machine weighs 40 tons. With a feed of 1-25 inch the machine can, without difficulty, take a cut ¼ inch in thickness. A blade of the *Kaiser Wilhelm II.* was shaped in 150 hours, a roughing as well as a finishing cut being made in this time. The blade has a length of 8 feet 3 inches, and a surface of nearly 37 square feet. Only one man is required for attending to the machine. In setting up the work a blade is located by shifting it on the studs securing it to the hub, until the pitch is as nearly uniform as possible all over the face. Turning the blade to accommodate the conditions is permitted by the slotted holes for the studs, this being the usual practice to permit slight changes to be made in blade-pitch, if found desirable after the test runs have been made.

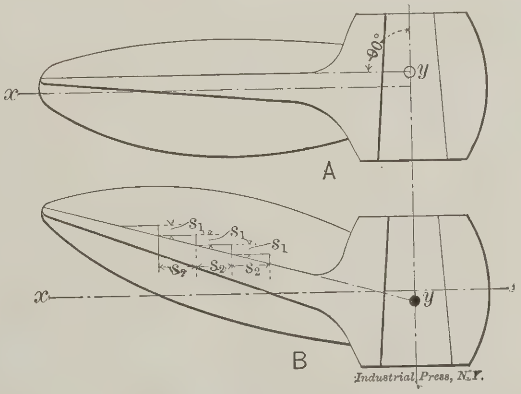


Fig. 4.

* * *

In one American shop that we know of, the metric system is used on special work without trouble by simply directing the workmen to measure "so many marks" on a metric scale without any attempt at converting distances into feet and inches.

SUDDEN DEATH OF ROBERT H. THURSTON.

As we go to press with the last form of this number, the announcement comes of the sudden death of Dr. Robert H. Thurston, Director of Sibley College of Engineering, Cornell University, on the evening of October 25th. Dr. Thurston was sixty-four years old on the day of his death, and had invited several members of the faculty of Cornell University to take dinner with him in honor of his birthday. He had just returned from a walk on the campus and was awaiting his guests in the drawing-room of his residence when suddenly he fell into a stupor, and died shortly after from heart disease.

Dr. Robert H. Thurston.

Robert Henry Thurston was born in Providence, R. I., in 1839, the son of Robert L. Thurston, one of the first builders of steam engines in this country. He was educated at Brown University, being graduated from there in 1859. He was employed in his father's shops until the beginning of the Civil War, when he joined the engineering corps of the United States navy. He served on several vessels during the war, and for gallantry and commendable service as an engineer was twice promoted, and toward the close of the war received his commission as first assistant engineer.

At the end of the war he was appointed a professor at Annapolis. He resigned his commission in the navy in 1872, having previously accepted an appointment to the chair of mechanical engineering in the Stevens Institute.

In 1871 Dr. Thurston became Professor of Engineering at Stevens Institute of Technology, Hoboken, N. J., and his fifteen years of service there showed him to have executive ability of a rare order, and profound technical knowledge. During his stay at Stevens he, in conjunction with President Morton, did much to advance the fame and standing of the Institute among mechanical engineers, both in this country and abroad. In 1885 he was called to Cornell University to take the directorship of the then newly organized Sibley College of Engineering, and his administration there has been phenomenally successful.

Dr. Thurston was the first president of the American Society of Mechanical Engineers, and has contributed a large number of papers to the proceedings of this society, probably more than any other author. He was highly talented both as a speaker and a writer, and was able to express himself with such ease and fluency that it was always a pleasure to listen to him or to read his writings. Nowhere was his remarkable grasp of affairs and his capabilities as a worker more evident than in these writings, which followed each other in rapid succession, and yet were in most cases of great merit. This was particularly so in some of his more recent papers in which he summarized the state of the art with respect to certain important engineering questions, like steam jackets, superheated steam, the steam turbine, etc.

The text books from the hand of Dr. Thurston were many, the best known being his volumes on the materials of construction, steam boilers and steam engines. Another book that has had a large sale was his "Friction and Lost Work in Machinery." As a text-book writer he often collected and summarized the conclusions of others rather than confining himself to his own personal investigations; and in this respect was frequently criticised. But his grasp of engineering subjects was so secure and his ability for drawing fair conclusions so good, that we consider it fortunate, rather than otherwise, that he saw fit to collect the great number of data that he did and place them where they may be conveniently referred to.

As a teacher Prof. Thurston was able to inspire his students with high ideals and always insisted that they should take up engineering on a broad gage plan. While he undoubtedly appreciated the necessity for careful attention to the details on the part of the engineer, he also knew that the engineer who has to achieve distinguished success must also be a man of affairs, and have a knowledge of men of affairs and of their ways. This spirit of broadmindedness, which he himself had, and attempted to inculcate into his students, was probably the distinguishing characteristic of Dr. Thurston.

* * *

THE GREAT CATHEDRAL COLUMNS OF NEW YORK.

The great columns for the Cathedral of St. John the Divine, New York City, are the largest monuments composed of one or a few pieces of stone ever built in this country. They are monuments because each one is a memorial, the expense of which was defrayed by some wealthy person. It was originally intended that these should be monoliths and over two years ago we published a description of the immense lathe that was designed for turning the great blocks of stone and converting them into cylindrical columns. The failure of the attempt to turn them in one piece has also been discussed in this journal. One or more of the columns broke before being finished, probably because no center rest was provided for supporting the stone midway between head and tailstocks, and it was decided finally to make the columns of two pieces each. The lower and larger piece in each case is 38 feet long and 6 feet diameter and weighs upward of 90 tons. Next in size in the way of a home product are the front columns of the New Hall of Records, New York; but these are only 36 feet long and 4 feet 2 inches diameter, weighing 40 tons, or less than half the weight of the largest stones in the columns of the Cathedral of St. John the Divine.

Comparisons with other large monuments of the world, show that Americans, with their advanced methods and improved machinery, are still far behind in stone working. Figures published by the *Philadelphia Record* show that the obelisk in Central Park, New York, is 69 feet high, 7 by 8 feet in cross section at the base, and weighs 220 tons. It was quarried more than 3,500 years ago, without the aid of any except the simplest mechanical devices. Largest of all the obelisks is the one at Rome, which is 108 feet tall, 8 feet square at the base and weighs 450 tons. At Karnak, Egypt, there is a great column which weighs 297 tons. It is 60 feet high and 11 feet in diameter. In Rome, again, is Trajan's Stone, a stupendous column 127 feet 6 inches high. It weighs 300 tons. Cleopatra's Needle, in London, a companion to our obelisk, is 71 feet high and has a base of 7 feet 7 inches. It weighs more than ours. In Alexandria is the famous Pompey's Pillar. It is 104 feet tall, and weighs 400 tons.

* * *

The theoretical water power of the world has been thus roughly computed by John Clarke Hawkshaw, of the British Institution of Civil Engineers: Assume a depth of 10 inches of rainfall to flow off each square inch of land surface, the mean height of which may be taken as 2,250 feet above sea level. Then the water from the whole surface falling through the mean height would give 10,340,000 000 horse power in perpetuity. Our present yearly output of 225,000.000 tons of coal would give that horse power for only a day under very economical conditions.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

For the past year or so, interesting experiments in high-speed electric traction have been conducted on the Berlin-Zossen military railway, which was specially constructed for high-speed work. Announcement was made by cable October 6 that the experimental car had attained a speed of 125.8 miles per hour without damaging the roadbed or machinery. The experiments made last year were unsatisfactory, as the roadbed was not equal to the stress imposed on it by high speed. The attempt will now be made to increase the speed to 140 miles per hour. The current is three-phase at a pressure of 13,000 to 14,000 volts and is reduced by transformers on the car to 450 volts. The car has four motors, giving an aggregate motive force of nearly 1,100 horse power. The results so far reached have led the engineers, it is said, to recommend a speed of 93 miles per hour for commercial purposes on the State Railway between Berlin and Hamburg.

The most persistent experimenter, as well as the most scientific investigator, in regard to aerial navigation in this country has been Prof. Langley, the secretary of the Smithsonian Institute, Washington. His many years of effort, however, have again resulted in failure the past month. His aerodrome, perfected as far as his knowledge would permit, was launched into midair from a high staging, hovered uncertainly for a moment, and then plunged downward into the Potomac. It is said that the total failure of this trial was due to a certain part of the mechanism catching when gliding along the launching ways. Prof. Langley has conducted his experiments in part under government aid, though we do not know on what grounds the appropriation for this purpose was made. While he may not live to see human flight a reality, or even a reasonable possibility, it is certain that his efforts will have contributed materially to our store of knowledge on the subject of flight, and his many attempts, even if failures, are but steps to be expected in dealing with a problem of almost infinite difficulty.

The power plant equipment for the New York terminal of the Pennsylvania Railroad for operating the trains in the projected tunnel under the North River is to consist of Westinghouse-Parsons steam turbines of the horizontal, short-barreled type. There are to be three turbines, each of approximately 7,400 electrical horse power, which will drive 5,500-kilowatt three-phase, alternating-current generators, operating in parallel. Their overload capacity will be over 11,000 horse power and each turbine will be provided with a by-pass automatically controlled by the governor to accommodate abnormal fluctuations in load. This will also permit operation at full load, non-condensing. The turbine equipment will operate under conditions favorable to the attainment of high economy, viz.: 200 pounds steam pressure at the throttle, 28 inches vacuum and 175 degrees F. superheat. The generator will be direct-connected to the turbine shaft through a flexible coupling, each section of the unit having two bearings of ample proportion, thus avoiding shaft stresses. The three-phase winding will deliver current directly to the distribution system at 11,000 volts, no step-up transformers being employed.

The introduction of blueprints into the United States was not such a rapid process as the present universal adoption of this method of copying tracings might indicate, says the *Engineering Record.* The first prints of this nature shown in the country were part of an exhibit in the Swiss section of the Centennial Exposition, and it was stated by one of the gentlemen in charge of that exhibit that the process had but recently been introduced into Switzerland from Germany. Mr. Rudolph Hering was requested to prepare an article for the proceedings of the American Society of Civil Engineers on the Swiss display, and came across these prints while engaged on this work. He obtained a copy of the formula for the solution, and after some trouble secured the ingredients and tried the process at his home. This was in 1876, and was probably the first case of blueprinting in the United States. He sought to interest the city engineer of Philadelphia in the process, but Mr. Smedley, who then held the office, refused because the operations would be too sloppy. Then he showed some of his prints to Dr. Coleman Sellers, but that eminent engineer refused to see anything good in them. Workmen, he said, were so accustomed to working from drawings in black ink on white or brown paper that the attempt to introduce drawings with white lines on a blue background would be the cause of serious trouble.

In a consular report reference is made to a type of oil engine developed abroad in which the oil is vaporized and ignited without the use of any external source of heat. The main drawback has been that the engine would not run indefinitely with light loads, owing to the explosions not occurring with sufficient frequency to keep the igniting portion at a sufficiently high temperature. A modification of this type of motor brought out by the Britannia Company, of Colchester, England, is claimed to be free from this drawback. The vaporizer is arranged, as usual, at the back of the cylinder. On the suction stroke a vapor valve is opened by the cam shaft, and through this valve air is drawn into the cylinder through the vaporizer, into which at the same time a little oil is sucked through an automatic valve. This mixture of air and oil is in itself too rich to be explosive and the main supply of air is drawn through a separate air valve into the cylinder. Two passages connect the vapor valve with the cylinder. One of these is large and straight, while the other is narrow and U-shaped. The lower portion of the U contains the igniter—a piece of metal having ribs, which enable it to absorb heat readily when the explosion takes place. This piece therefore becomes and remains red hot, while the rest of the vaporizer is only at a black heat. The vapor which is drawn through this igniter on the suction stroke is far too rich to burn, but on the compression stroke air is forced back into the igniting piece and provides the necessary oxygen for the vapor already there to ignite. None of the exhaust passes through the igniter, which is consequently not cooled down in the case of a missed explosion. The proportion of oil and gas used is regulated by throttling the air supply. As already stated, part of this air is drawn through the vaporizer and the rest through the air valve. If the admission to the latter is throttled a greater proportion of the air used will be taken through the vaporizer and will carry with it a proportionately greater amount of oil. The makers claim that, once started, the engine will run absolutely without attention for several hours.

SHOCKS FROM ELECTRIC LOCOMOTIVES.

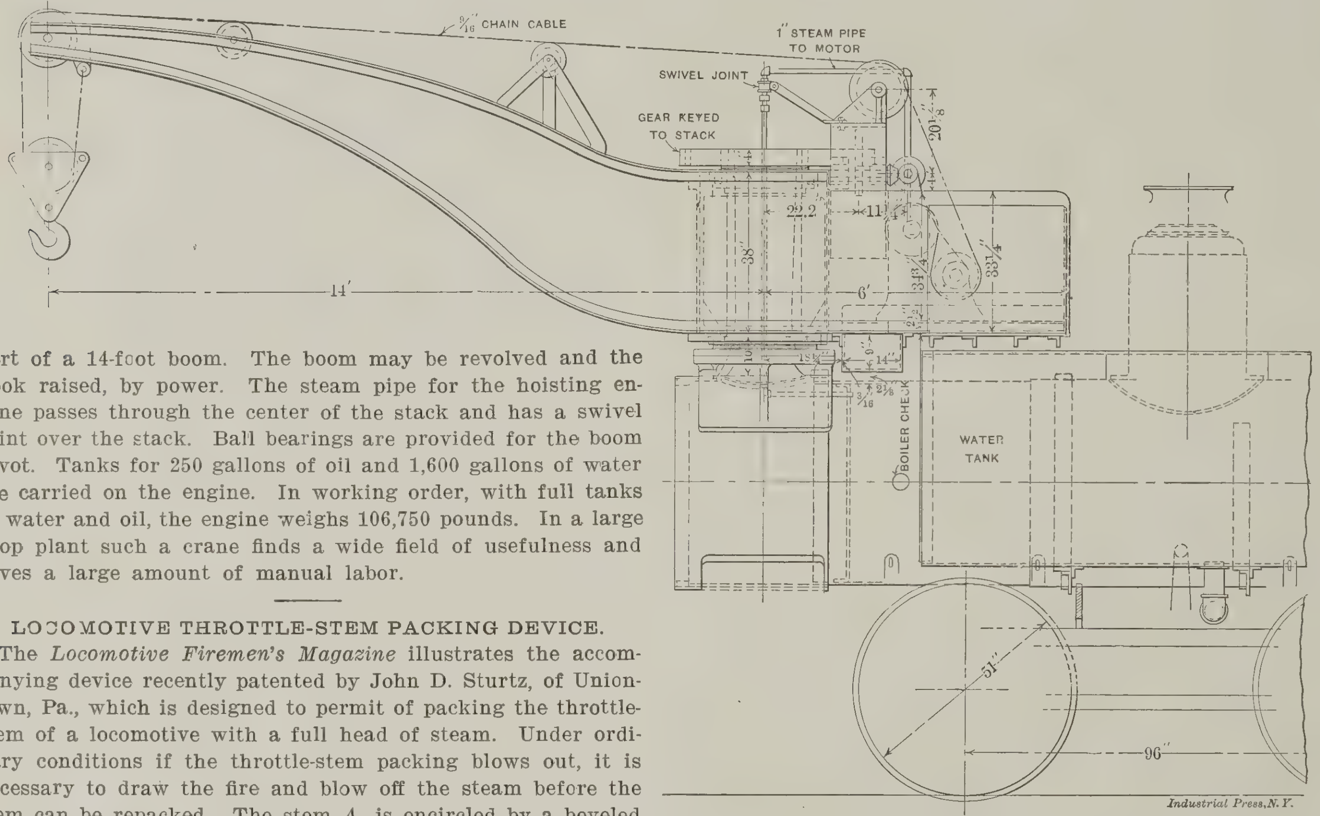
Street Railway Journal, August 22, 1903, p. 247.

Electric locomotives or cars having voltages more dangerous to life than the common 600-volt direct-current are few as yet, but with the introduction of alternating current their number will increase; and it is in order to call attention to one element of danger in their operation which cannot be too carefully guarded against. It is a danger for which prevention is easy, but is nevertheless a real one, and has already resulted in at least one serious accident in this country. We refer to the possibility that a locomotive may run onto a portion of track covered with sand or dirt, so that there is a partial insulation between the wheels and rails. In such a case, if the locomotive is running on a grounded circuit, using the rails as a return, there is an excellent chance for employees to receive serious shocks in attempting to board the locomotive, because there is likely to be a dangerous voltage between the locomotive frame and ground. Shocks from this cause have not been unknown in street railway practice, but the voltage is usually not dangerous to life on a street railway system, and there is considerable insulating wood in the make-up of a car. On an electric locomotive, using high-tension electric current, and having a steel frame, however, a shock of this kind is almost certain to be attended with disagreeable consequences. Although the possibilities of a shock from this cause are apparent, consideration is not usually given to the danger, so we feel justified in uttering this warning. One obvious remedy is to omit the sand boxes from such a locomotive's equipment, and furthermore, if the locomotive is ever to operate on dirty rails, it should be equipped with a set of brushes for brushing the rail in advance of the wheel.

SWITCH ENGINE EQUIPPED WITH CRANE.

American Engineer & R. R. Journal, October, 1903, p. 391.

A convenient locomotive crane of four tons lifting capacity has been fitted up at comparatively little expense at the Topeka shops of the Atchison, Topeka & Santa Fe and will be used about the locomotive shops and yards. An old four-wheel switch engine was equipped to burn oil (so that it may safely enter the buildings) and fitted with a substantial cast-iron stack, with a large base, forming the pivot and support of a 14-foot boom. The boom may be revolved and the hook raised, by power. The steam pipe for the hoisting engine passes through the center of the stack and has a swivel joint over the stack. Ball bearings are provided for the boom pivot. Tanks for 250 gallons of oil and 1,600 gallons of water are carried on the engine. In working order, with full tanks of water and oil, the engine weighs 106,750 pounds. In a large shop plant such a crane finds a wide field of usefulness and saves a large amount of manual labor.

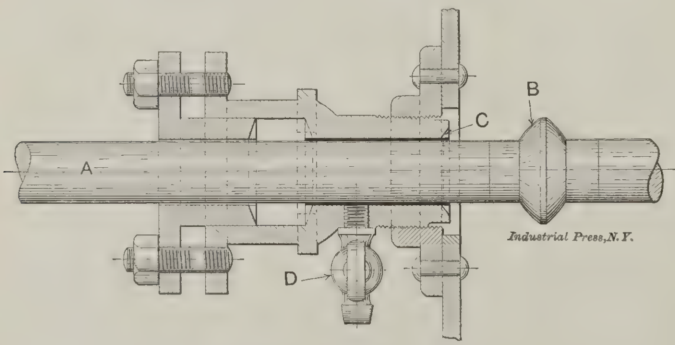


Industrial Press, N.Y.

Crane Attached to Switch Engine.

LOCOMOTIVE THROTTLE-STEM PACKING DEVICE.

The *Locomotive Firemen's Magazine* illustrates the accompanying device recently patented by John D. Sturtz, of Uniontown, Pa., which is designed to permit of packing the throttle-stem of a locomotive with a full head of steam. Under ordinary conditions if the throttle-stem packing blows out, it is necessary to draw the fire and blow off the steam before the stem can be repacked. The stem *A*, is encircled by a beveled ring *B*, preferably integral with the stem, which, when the throttle is opened to the full extent, bears upon the beveled seat *C*. and shuts off the flow of steam or water into the stuffing-box cavity. The stem is swiveled so that it can be rotated without disconnecting the lever, the object of this being to grind off any scale that may have settled on the seat *C*. To pack the throttle all that is necessary to do is to place the engine so that the cranks on one side are on a center, disconnect the slide valve-rod from the rocker, and cover the steam ports with the valve. The ports on the other side can be covered by placing the reverse lever in the middle notch of the quadrant. The throttle lever can then be pulled wide open without admitting steam to the cylinders. The pet-cock, *D*, is a telltale by which the engineer can determine whether the ring, *B*, is seated tightly enough to make it safe to loosen the nuts and remove the gland.



Industrial Press, N.Y.

Packing for Throttle Stem.

The principle of the device is identical with that of the Jenkins valves; these can be packed under full pressure when open by screwing the valve upward until it abuts against the under side of the stuffing-box, thus shutting any flow through the gland.

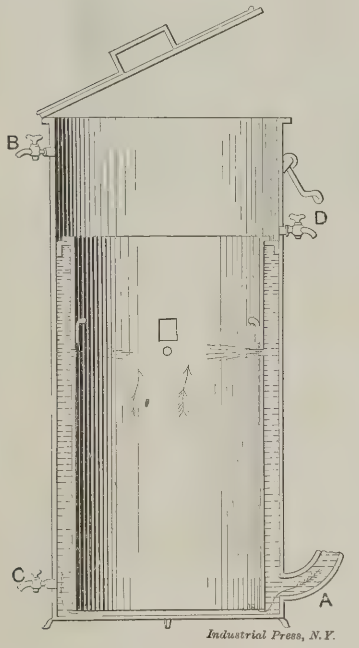
THE REASON FOR THE VERTICAL DESIGN OF THE CURTIS STEAM TURBINE.

Extract from Paper read by W. L. R. Emmet before the American Street Railway Association, Saratoga, N. Y.
September 2-4, 1903.

The question as to why the vertical shaft design was adopted for this unit (5,000 K. W. unit for Chicago station, 25 feet high, 14 feet in diameter and weighing 400,000 pounds) has often been raised and many doubts and criticisms concerning it have been expressed. It is not easy to explain all the reasons which led up to its adoption but it may be said that the compactness and simplicity of this unit, which are its most marked characteristics, are largely due to the merits of this design. With the vertical shaft arrangement all lateral strain is removed from the bearings which align the shaft and all deflection of the shaft is avoided with a minimum number and length of bearings. This matter of properly supporting a shaft and keeping it exactly central and in perfect alignment is an important one where small clearances are desirable with a large diameter in the revolving part. To carry such weights as are necessary in the revolving part of this large unit many very large bearings would be required if the shaft was in a horizontal position. An elaborate system of forced lubrication with artificial cooling would be necessary in connection with these bearings, and a failure of any of these bearings would occasion serious danger to the operation of the machine. If the machine were built in a horizontal position it would be very difficult to so support the wheels that their clearances would not be affected by sagging of shaft or looseness in bearings, and also, it might be difficult to place them with such a relation to each other that the clearance would not be affected by expansion of the shaft. In the vertical design the space between wheels is reduced to a minimum, the supporting structure is perfectly symmetrical and cannot be in any way distorted or put out of line either by mechanical or steam pressure strains or by the effects of expansion.

STEEL HARDENING APPARATUS.

Zeitschrift fur Werkzengmaschinen und Werkzenge, June 5, 1903, p. 371.



Hardening Tank.

After a number of trials and experiments, Louis Bahner, of Berlin, has brought out an apparatus for hardening steel that is said to overcome the well-known troubles and difficulties surrounding that class of work. The treatment depends upon the fact that the object is to subject the whole piece to a continuous stream of water forced into a tank, in such a way that an equal and uniform hardening is obtained. As the result of the contact of the red hot piece of metal with the surrounding liquid, it is well known that a steam envelope is formed about the former, which prevents the access of the water to the hot surface and thus checks the hardening process. Even by moving the piece about in the water this difficulty is not altogether obviated; for, if a closer contact of the hardening liquid is obtained on the side toward which the piece is moving, there is still the existing steam pressure on the other side.

The illustration shows one form of the apparatus referred to, as designed for large pieces. The water is delivered through the pipe *A* and enters the inner cylinder at four points, opposite where the piece to be hardened should be placed, and flows out at *B*. In smaller designs the water is admitted at the bottom only. The object is to cause a current of water of uniform temperature to flow evenly over all of the surfaces of the submerged piece and thus produce a constant rate of cooling at all points.—G. L. F.

ELECTRIC CONTROL OF COMPRESSED AIR BRAKES.

Annalen fur Gewerbe und Bauwesen, May 1, 1903.

The electro-pneumatic system of controlling air brakes, as exploited by the Siemens Company, permits a simultaneous action to be obtained at all points on a train. The brakes upon each car act automatically whenever the pressure in the train pipe is lowered below a fixed point. No change is made in pre-existing arrangements and the apparatus can be worked as before when the electric apparatus is cut out.

Valves are put into a pipe leading from the main train pipe to the brake cylinders. These valves are kept closed by the air pressure, but can be opened by the action of electro-magnets and thus cause an application of the brakes. The current is sent through the magnets by a switch attached to the handle of the engineer's valve, and similar switches and cocks are placed in each of the cars to be used in case of emergencies.

A switch operated by a piston which is subjected to main train pipe pressure upon one side and is balanced by a spring on the other, serves to close the circuit, if, for any reason the train-pipe pressure is lowered; so that the brakes are at once applied. A complementary arrangement serves to apply the brakes in case of any breakage of the wires or short-circuiting.

The following advantages are claimed for the system: The brakes are applied without shock to the train, regardless of their length or speed, or whether the application is made from the locomotive or a car; the efficiency of the braking is independent of the distribution of braked cars throughout the train, while the purely pneumatic system is dependent solely upon the unbroken succession of braked vehicles; the electric control at once utilizes the train-pipe pressure without permitting it to escape, thus reducing the consumption of compressed air; the conditions of brake application since it takes place in case of a break-in-two as the result of the action of either the pneumatic or electrical portion of the apparatus and the engineer can test the brakes without leaving his place or requiring assistance.

A battery of twenty cells supplies the current for the operation of the device.—G. L. F.

ELECTRIC SOLDERING.

Moniteur Industriel, September 12, 1903, p. 574.

This process of electric soldering is especially adapted for use in foundries and steel works and is giving excellent results in practice. It was developed and is in use by the Societe d'Electricité et d'Hydrauliques, at Charleroi, France. It consists of causing an arc to play between the piece to be soldered and a bar of soft iron. It effects a great saving over those methods of soldering where an oxyhydrogen flame is used or of those where molten metal is caused to flow over the part to be filled.

A complete installation for the work consists of a direct current generator; a switchboard, a secondary switchboard upon which the soldering apparatus is placed; a rheostat and the soldering apparatus. The dynamo is a direct-current machine with a capacity of 26 effective kilowatts and developing 400 amperes under a normal tension of 65 volts. The induction coils are so wound that they can sustain a considerable overload, the amperage rising suddenly from 0 to about 1,200 at the instant of production of the arc. The dynamo can also work without sparking from 0 to 1,200 amperes.

In the operation the workman holds a sheet of violet glass in one hand, both to protect himself from the effects of the arc and to enable him to adjust the soldering apparatus to exactly the right place. With the other hand he manipulates the apparatus proper, which consists, according to the weld that is to be made, of a bar of iron or carbon fastened to the end of a wooden handle that is fitted with a guard to protect the hand. The work consists of causing an arc to play between the piece to be soldered and the soldering bar, and can be done in one of two ways. Iron filings can be put into the hole to be filled and then melted by means of an arc made to play between it and the solid metal, more filings being added until the hole is filled. A carbon welding bar cannot be used when the parts are to be machined, as the results leave the metal harder than the original piece.

The second method is to cause the arc to play between the piece to be soldered and the soft iron bar. The latter is melted by this operation, lowers the temperature of the arc and furnishes the material needed for the soldering. This lowering of the temperature of the arc avoids overheating the metal.

These operations require the services of two men; one handles the soldering apparatus while the other changes the bars, adds the filings and hammers the metal when the arc is cut off. When the soldering is well done a perfect union of the metal that has flowed in with that of the main piece is obtained, for the two are united while in the liquid state—a condition that does not obtain with the ordinary methods of doing the work. The saving effected by this method is very great as compared with the use of the oxyhydrogen blow pipes or fused metal, while in many cases it makes it possible to effect repairs upon defective pieces that would otherwise have to be consigned to the scrap heap on account of the trouble and expense involved in doing the work.—G. L. F.

THE RATEAU STEAM TURBINE.

A. Rateau, in Engineering Magazine, Oct., 1903, p. 49.

The Rateau multi-cellular turbine, the result of an especial study of the subject by the writer, was briefly described in 1900, in a report presented by him upon the subject of steam turbines at the International Congress of Applied Mechanics at Paris in July, 1900. In designing this machine it was sought to satisfy the following conditions:

1. The attainment of a high mechanical efficiency, together with as low an angular velocity as possible.
2. The provision of a large, and at the same time non-injurious clearance between the fixed and the moving parts.
3. The attainment of the least possible weight of the whole machine, and especially of the rotating parts.

The revolving wheels are formed of disks of thin sheet steel, as shown in Fig. 3, carrying cylindrical buckets on the periphery, these buckets being riveted to a band of steel welded to the disk. This gives a very light and strong construction, maintaining its balance at all speeds. The guide buckets are fixed in circular diaphragms, secured at the periphery in grooves cut in the interior of the turbine case. There is thus left between the successive diaphragms a series of annular chambers in which the revolving wheels are placed, Fig. 2. The shaft passes through bushings fitted in the diaphragms, there being but little play or clearance. Between the fixed and revolving portions of the turbine, however, the clearance may readily be made as much as 5 or 6 millimetres, without injury. The main bearings of the shaft are generally outside of the casing, a special form of stuffing box being employed, assuring tightness against leakage. The external appearance of the machine is shown in Fig. 1.

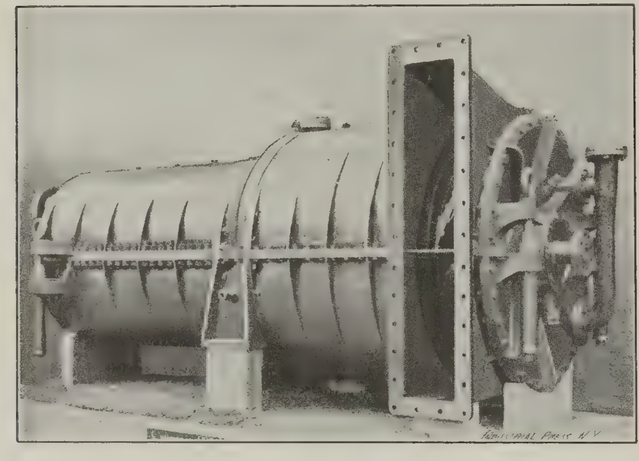


Fig. 1. Rateau Turbine.

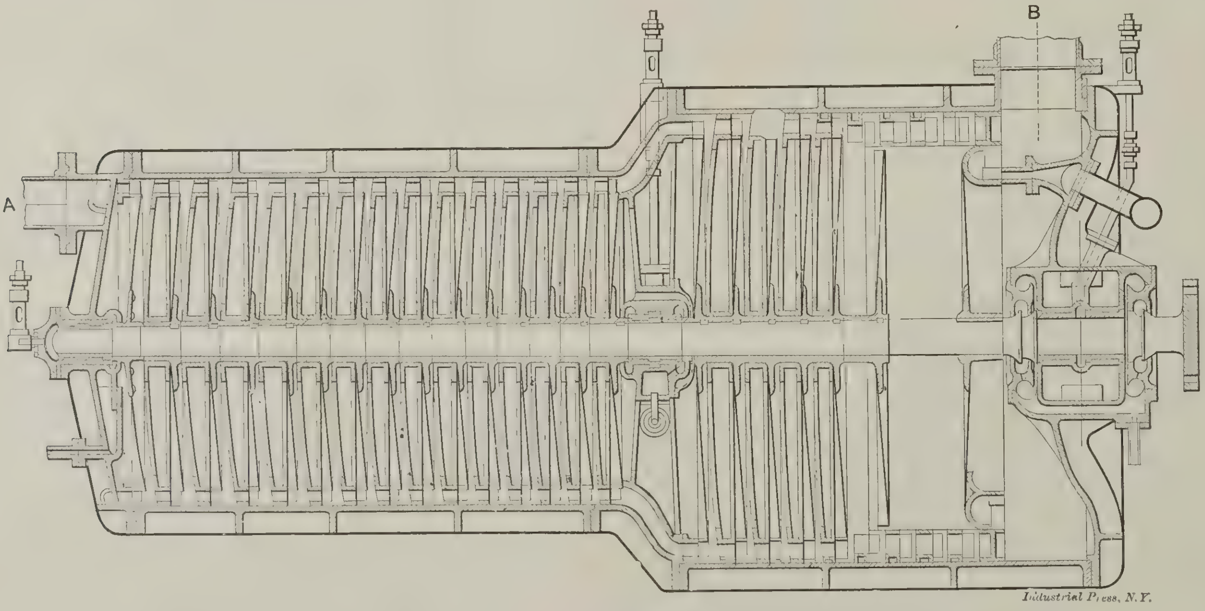


Fig. 2. Sectional Elevation of Rateau Turbine. Steam Enters at A and Exhausts at B.

An ordinary compensated centrifugal governor is used to regulate the speed, acting by varying the pressure of the steam delivered to the turbine. By means of a by-pass in the main steam pipe it is possible to deliver steam of full pressure both to the entrance of the turbine and to a point in the machine nearer to the condenser, this enabling a higher power than the normal amount to be produced by the machine, much in the same manner as a compound engine may be used with full pressure steam in both high and low pressure cylinders.

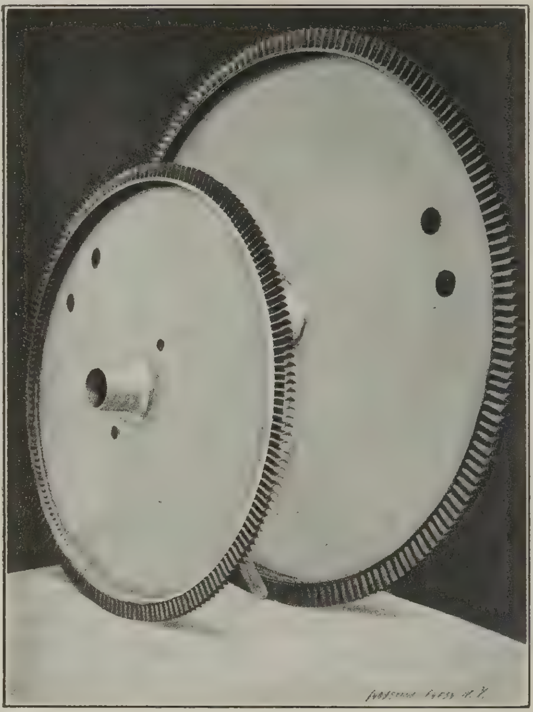


Fig. 3. Two of the Rotating Turbine Disks.

PLATING PROCESS.

Engineering News, August 27, 1903, p. 192.

A peculiar plating process is being employed in Germany to produce sheet-metal consisting of several layers of different metals. The process utilizes the adhesive qualities of aluminum at moderate heat. A typical product is a sheet of iron (soft steel) coated on both sides with copper, the completed sheet having about 15 per cent of copper. Such sheets can be used as a roof-covering, either plain or corrugated, in place of copper on wood, or in place of galvanized iron. The process of making such plates is as follows: A copper plate is cleaned and roughened by sand blast, and is then rubbed over with a piece of aluminum, which forms a thin partial coating of aluminum on the copper. A thin sheet of aluminum is then laid on the prepared copper plate, the two are heated to about 800° C., and then passed through the rolls and rolled out into a thin sheet of copper having an aluminum plating on one side. By laying two such sheets, aluminum side down, on the two sides of a clean iron plate, and heating to about 400° C. in a muffle furnace, the sheets may be rolled together and a partial adhesion secured. The combined sheet is then heated to a higher heat, about

800° C., and rolled out to the desired thickness, a perfect adhesion being thereby secured between the iron and the copper by virtue of the layer of aluminum between them. Other combinations than this one are produced in the same general way; examples are copper-aluminum sheets, copper-aluminum-copper, steel (soft steel) coated with aluminum on one or both sides, or an aluminum core coated with steel, combinations of copper and zinc, of aluminum and zinc, or of all three metals, etc. The process is the invention of Mr. H. Wachwitz, of Nürnberg, and is being exploited by the German Wachwitz-metal Co., of Hersbruck, Germany.

THE PHENOMENON OF LIGHTNING.

From Paper, "Safeguards Against Lightning," read by Alfred Hands before the Fire Prevention Congress in London, July 6, 1903.

At the best, lightning is too often regarded as an electric current overcoming the resistance of the air; but this resistance has nothing in common with that which is the subject of Ohm's law, and to consider it merely as a momentary current is apt, I think, to give a somewhat misleading view of the matter. I want you to regard it as a breakdown of the dielectric—not as something leaving the sky to come to earth, or as being hurled from the clouds to strike a building, but to consider it—as indeed it is—as a fracture or cracking both of the air and of any other resisting medium between the oppositely charged bodies, the clouds and the earth. As a mechanical analogue, one may liken the air under these conditions to a thick slab of glass subjected to an enormous pressure from above and below, and which will crack when the pressure is greater than the material will bear. A building may be considered as a weaker object firmly embedded in the glass. We may, in fact, regard ourselves as living between the inner and outer coatings of an enormous Leyden jar or other condenser. Now, when the stress to which the air is subjected has reached the breaking point, which is about half a gramme weight per square centimeter (about 1-9 ounce per square inch), the line of the fracture becomes visible by the intense heat making the air particles momentarily incandescent, and this we call "lightning." The building which, being in the line of the strain, gets damaged, forms only a part of the fracture; the air is equally damaged, but is a self-repairing medium. Unfortunately, our buildings, trees and bodies, which are less resisting than the air, are not self-repairing, and so we get the deplorable losses of life and property that occur every year. A building offers less resistance than the surrounding air, therefore the breakdown would tend to go through a building rather than pass it by and go through the air beside it, even if there were no metals in it to render it still more weak. Even allowing for the effects of induction, lightning can no more be attracted by a conductor than a crack across a sheet of glass can be attracted by any weak part which would cause it to take other than a straight course.

DROP FORGING.

Proceedings of Engineers' Society of Western Pennsylvania, June, 1903, *p.* 292.

In a paper on drop forging read before the May 19 meeting of the Engineers' Society of Western Pennsylvania Mr. Dwight Goddard outlined the process of making drop forgings. That portion of the paper describing the dies is given in the following:

A set of dies consists of forging dies, outside trimming dies and, if there are any holes in the forging, inside trimming dies. The forging dies are the most important item. A pair of dies usually consists of two blocks of tool steel in which have been cut the shape to be forged. There are often two or more impressions in the same die block. On one side is an impression for breaking down or blocking out the metal, then a roughing impression that distributes the metal and approximates the shape and a finishing impression that brings the forging to exact shape and dimensions.

The shape and sequence of these impressions must be carefully considered to provide for a natural flowage of metal under hammering and to be such that the desired shape will be surely, quickly and economically formed. There must be no place short of metal, no overlapping and consequent "cold shuts" and no unnecessary blows or waste of stock. A draft of 5 to 7 degrees from the perpendicular must be allowed to permit a free release of the forging from the die. This is especially necessary if the section is such that an unusually quick chilling of the stock would cause the forging in shrinking to grip the die.

It requires a specially trained machinist known as a "die sinker" to make these dies. He must have experience and knowledge as to the action of metal under hammering, must have good judgment and high skill to enable him to plan, lay out and make the impressions. He must have a ready use of tools, both hand and machine, to reduce to a minimum, the cost of the labor in making, which will be high at best. The hand tools which he uses consist of a wide range of dividers, gages, shrink-rules, protractors, micrometers, rifflers, chisels, files, and scrapers; the machine tools, die sinking machines, sensitive drills, milling machines, profilers, shapers, etc. In designing the dies, it is always best to procure, if possible, a model of the piece to be forged. Then a full sized drawing should be made showing the draft, the allowance for finish and any changes that seem necessary, to be submitted to the customer for his approval.

When the dies are about done, as far as shaping the impressions is concerned, they are clamped together and a lead cast made, as a proof of the shape. This is also sent to the customer for his approval. If satisfactory, the impressions are nicely finished to insure free release of the forging. The face of the die is cut away slightly for from ½ to 1 inch from the edges of the impression, to permit the free escape of the flash, or surplus metal. A groove is also made from one end of the impression to the outside to provide room for the sprue, which enables the forger to manipulate the forging by means of the bar from which the forgings are being made. Lastly the dies are carefully hardened and tempered that they may give the maximum service.

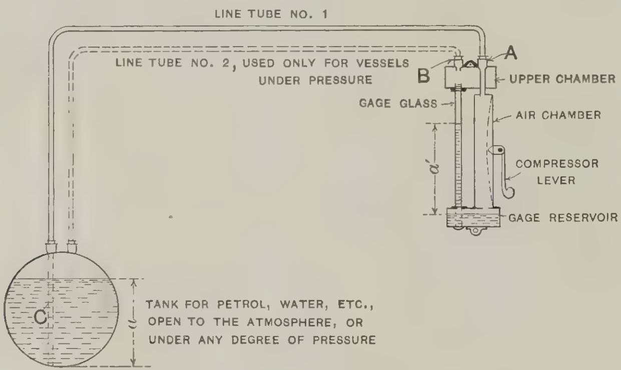
This is a very important operation and requires great skill in accomplishing. Even hardness of the face is essential, with no cracks or warping. By this time the dies represent great value, often hundreds of dollars. They should be capable of making from five to ten thousand forgings and the breaking of dies or the early wearing away of the edges may be a costly experience. The making of the dies is the expensive part of drop forging and forbids the making in small quantities.

The customer is usually charged only a part of the cost of making the dies, and while they are kept strictly for his use he is not permitted to remove them. In such a case the drop forger is expected to keep the dies and tools in good order and to make such repairs as are necessary and to replace them when worn out, at his own expense. The reasons for this custom are obvious. Each drop forging company has developed from this experience special methods for the designing and construction of dies, which they do not care to place at the disposal of competing companies. They are also seeking to accumulate an amount of dies that will provide them their principal business which is forging, not die making. If a customer insists on owning the dies outright he is charged the full cost of making with a reasonable charge for this engineering experience, and is expected to keep his own dies in repair.

THE DEPTHOMETER; A DEVICE FOR MEASURING THE DEPTH OF LIQUIDS IN TANKS, ETC.

Daily Consular Report, No. 1772.

United States Consul Waterman at Dublin, Ireland, describes a depthometer invented by Mr. Leonard Murphy and manufactured by Daniel Miller & Co., Dublin. It is an instrument designed to show the depth of liquids either in open vessels—such as water tanks, vats, ship's holds, wells, etc.—or of liquids inclosed in vessels under any degree of pressure, as in the case of petrol tanks in some motor cars and other vessels of this kind. It may be placed at a distance from, and at any level relative to the tanks—above, below, or on a level with them. Any number of tanks may be connected to one depthometer and the depth of each ascertained by indicating one at a time. The reading of the indicating column of the depthometer is absolute, marking to a fraction of an inch the depth of the liquid being indicated. The reading can, of course, be reduced proportionately by using mercury or other heavy liquid for the indicating column. No floats or moving parts are used in the vessels being indicated, a fixed pipe of small bore being all that is required. The diagram shows the depthometer attached to a tank containing liquid. The instrument, shown in section, is placed somewhat above the tank and registers the exact depth of liquid in the tank by means of the column of liquid seen in the gage glass. When wishing to ascertain the depth of liquid in the vessel connected, it is merely necessary to raise the lever marked "compressor lever" and bring it back again to its starting point. On doing this the exact depth being measured will be shown by the column in the gage glass of the depthometer.


LINE TUBE NO. 1
LINE TUBE NO. 2, USED ONLY FOR VESSELS UNDER PRESSURE
A
B
UPPER CHAMBER
GAGE GLASS
AIR CHAMBER
d'
COMPRESSOR LEVER
GAGE RESERVOIR
C
d
TANK FOR PETROL, WATER, ETC., OPEN TO THE ATMOSPHERE, OR UNDER ANY DEGREE OF PRESSURE

Industrial Press, N.Y.

Device for measuring Depth of Liquid in a Tank.

The parts of the depthometer shown in the diagram are as follows: Two chambers, fixed one above the other, are connected by a gage glass tube, open at both ends, which reaches almost to the bottom of the lower chamber and only just enters the upper chamber from beneath. The top one is called the "upper chamber" and the lower chamber is called the "gage reservoir." The latter has attached to its top a flexible "air chamber" capable of being enlarged or reduced in volume by the compressor lever shown in the diagram. To the upper part of the air chamber a short tube and coupling, *A*, is attached, from which the line tube, No. 1, can be carried to the distant vessel, terminating in a dip pipe, *C*. If the vessel be under pressure a second line tube, No. 2, is necessary and is laid beside the first tube, reaching from the top of the tank to upper chamber, coupling at *B*, as shown in dotted lines on the diagram. This pipe is, however, not used if the vessel be open to the atmosphere, and in that case coupling *B* is left open to the air. The gage reservoir is next almost filled with the indicating fluid (petrol, water, etc.), and when at rest the liquid should just appear at the base of the visible portion of the gage glass. The instrument is then ready for use.

The method of working is as follows: Raise the compressor lever to its highest point, thus causing the air chamber to expand and take in a supply of air; the latter enters at coupling *B*, passes through the upper chamber, down the gage glass, through the liquid in the gage reservoir, and finally reaches the air chamber. On depressing the lever the air in this chamber becomes compressed and presses on the liquid in the gage reservoir. The air cannot, however, return through the gage glass, as the end of the latter is sealed by the indicating liquid. Some of the air, therefore, passes into the line tube No. 1, and on reaching the tank forces out any liquid which may have risen in the dip pipe, *C*, and ultimately the excess of air escapes from the open end of the dip pipe into the liquid in the tank. During this operation the liquid column in the gage glass of the depthometer will be seen to rise gradually to a certain point and then stand. The column ceases to rise further the moment the air commences to escape at the open end of the dip pipe in the tank, and the column thus shown will be equal in height to the depth of the liquid in the tank, as it will be seen that the air, having completely filled the line tube, has created an exact balance between the column of liquid in the tank and the indicating column of the depthometer.

CYLINDRICAL GRINDING.

Extract from paper read by Mr. C. H. Norton before the Cincinnati Metal Trades Association, October 8, 1903.

There is very little doubt that the first glimpses of cylindrical grinding came to all mechanics when using the lathe, and that these early dreams were tried here and there by mounting a small emery wheel on the tool-post of the lathe. Just where and when this was first done would be difficult to ascertain, but so far as we know the first really accurate grinding was done at Waltham, Mass., by the watch tool concerns about 1860. Mr. Webster, the father of the watch tool business, told me a few years before his death, the story of their earlier grinding. After using the lathe for some time with a small wheel in the toolpost they discovered that in order to grind tapers they should keep the centers in line; this they could not do with the lathe of that period, so they made what they called grinding lathes, that is, lathes with wheel carriage traveling on a slide that could be adjusted to an angle with the line of centers. This was some time about 1865. These were perhaps the first grinding machines with fixed centers and traversing wheel. They were rightly called "grinding lathes." They were small, the wheel being 4 inches diameter by ⅛ face on a spindle about ½ inch diameter. The swing of these lathes was about 6 inches and the largest work done did not exceed 1 inch diameter, while the greater amount was less than ½ inch diameter.

Some time about 1865, Mr. Brown, of J. R. Brown & Sharpe, at Providence, R. I., was grinding needle bars for sewing machines with what was called a "grinding lathe," arranged for the carriage to traverse and reverse automatically. This carried a wheel 6 inches diameter by ¼ inch face. The idea of constructing a machine designed especially for cylindrical grinding and to cut entirely loose from all traditions and features of the lathe, except, of course, the supporting center points, seems to have originated with Mr. Brown; for in the years following 1865 he gave the matter considerable study, and at his death in 1876 he had invented the "universal grinding machine," which was not a lathe but had a fixed wheel and traversing work.

When we realize that some 26 years ago cylindrical grinding machines were manufactured and sold by one of the best known concerns in the world, and that 40 years ago cylindrical grinding was done successfully in some of the best known shops of the day, we cannot but feel a little surprise that after all these years so important a factor in the economical production of good machinery should be strange to so large a proportion of machine builders, and that journeymen machinists, with exceptions so few that they are noticeable, have either neglected or refused to learn to use the grinding machine. At the same time there is no tool on our lists that is held in greater awe than the grinding machine.

Twenty years ago grinding was considered essential to really good work by concerns that now enjoy the best patronage of the entire world, and fifteen years ago they had reached the point where it was impossible to produce their work as cheaply without grinding as with it. The best grinding machines of to-day produce from four to six times more work than those of twelve years ago; and yet while large numbers of American machine builders are using modern grinding machines, there is a class who demand proofs in the way of tests, etc., before they can believe that grinding is practical for their work. The reason for this condition can be traced to the fact that while there are a large number of grinding machines in use, they are "universal grinders." In fact so familiar has the universal grinder become that it is very difficult for mechanics to understand that there are now in successful use cylindrical grinding machines that are not universal, and that they do not grind complicated or tool work. But they do grind all cylindrical work that is turned in lathes on two centers, and that, contrary to experience with universal grinders, they do remove considerable stock in an economical manner, saving many hours (on single pieces of work) that without their use would be expended in lathe work.

There is a common belief that it must consume more time to grind away stock than to turn it away. Therefore we find many insisting that to grind more than six or eight thousandths from the diameter of cylindrical work must be an expense, and in fact to grind at all must cost more than to turn to size in the lathe. This belief has been strengthened by the fact that grinding machines in the past have been made as producers of accurate work only, with no thought as to the possibilities of reducing diameters economically.

Within the last three years there have been great changes in the design of machines and in the methods of handling work, as well as great improvements in grinding wheels. So great have been these changes and so really wonderful have been the results, that no manager can afford to judge by any experience gained by the use of machines of the older designs in the hands of operators trained under the older methods using wheels of older selection.

SPEEDS AND FEEDS.

From paper read before Cincinnati Metal Trades Association, by Frederick Holz, President Cincinnati Milling Machine Co.

We may listen with wonder to-day to one of our friends who is running a surface cutting speed of 100 feet per minute, and feel that this is the limit, only to learn to-morrow that our neighbor applies a speed of 150 feet per minute, and thus the increase in speeds goes on. To-day the speed barometer stands at 250 feet in one of our Cincinnati shops.

It is also true that while we read a great deal of fast feeds and speeds we see very little of them when going through the country visiting shops, for these things are in a very experimental stage. Most of our present machine tools are not satisfactory for high-speed tool steel. Whenever we undertake to use the new steel, we meet with all sorts of breakdowns and other difficulties.

We have often noticed on forged spindles and similar work, evidence of very coarse feeds used on the rough turned part as they come from the forge shop, and Mr. Lodge and I went to Pittsburg to see the methods by which these are made. At one of the Carnegie shops near Homestead, we witnessed an axle lathe taking a heavy cut ¼ inch deep on a 5-inch diameter axle as it came from the forge. The carriage on this lathe traveled 3⅜ inches a minute. This was done with a single, tool, Crescent self-hardening.

Later we took a trip through some of the large shops in the Great Lakes district and in Milwaukee. We were told of a speed which broke all records we had ever heard of. Mr. Schoeltke, superintendent of the Nordberg Mfg. Co. told us that he turned a 5¼-inch diameter shaft, reducing it to 5 inches, 22 inches long, in one minute. Very much to our disappointment, we could not see the actual performance, but we were shown the data and records of the test.

Upon returning I had a 24-inch lathe rigged up with a 5 horse power motor, which we supposed would have ample power. We commenced our experiments on a 4¾-inch diameter machinery steel shaft, such as we use for overarms on our milling machines, and it worked well. We got carriage travel on this job of 17 inches in one minute, taking a cut ⅛ inch deep. We could see that this was not the limit, but had already consumed 10 horse power for this one lathe and that was all the motor could stand. We had two Novo tools—one in front and one in back—and used the leadscrew for feeding, and geared it up same as for cutting 5 threads to the inch. Since that time we have arranged for a 12 horse power motor. I only mention this experiment to point out what we may have to look for in the near future as to power. Of course, this 4¾-inch shaft had all the advantages in its favor. It was short in comparison with its diameter and quite stiff. Two tools were used to counterbalance the strain. The material was uniform. Records like these cannot be made in every-day practice, but experiments of this kind have a good effect, in that they help to make things "speed up" all around in the whole establishment.

We are not altogether through with this experiment yet. I feel that by the time we get to the end the same shafts will be turned at the rate of 24" a minute. On planer work we run light roughing cuts ⅛ inch deep, 70 and 80 feet per minute on cast iron, provided the material is fair. We use variable speed countershaft, which is absolutely necessary on planers, since finishing cuts are run at the rate of 18 to 20 feet per minute on the same planer.

In milling machine practice it is very seldom a cutter is injured by a feed unless it is abused. It is an old and mistaken idea that a cutter must be fed slowly in order to preserve it. If we analyze this subject we will find that the chip per tooth of a milling cutter is very small in comparison with the chip of a lathe or planer tool, and it is better for the cutter to give it a fast feed instead of a slow one. It is certainly better for any tool to cut into the surface instead of simply rubbing over it, and the more positive and steady this feed is, the better it is for the cutter. This argument especially holds good for roughing out work. For finishing, a high speed may be applied and a finer feed used, with finer teeth in the cutter. For roughing cuts, cutters with very coarse teeth to allow room for the chips, should be used. On ordinary class of work the medium coarse-tooth cutter answers for both the roughing and finishing.

Example 1.—Material, .90 carbon tool steel; width of surface, 5 inches; depth of cut, 1-32 to 3-64 inch; cutter, 3 inches diameter; 56 revolutions per minute; table feed, 2.8 inches per minute. This is a severe test, but the No. 2 plain miller does the work right along without chatter, with limit of accuracy of .001 inch.

Example 2.—Cast-iron bar, 1 inch thick, in which a slot is milled 22 inches long; Novo steel end mill, working at surface speed of 66 feet; table travel, 4 inches per minute.

Example 3.—Roughing the top of vise housings for a milling machine; Ingersoll type cutter used, 4½ inches diameter, at cutting speed of 40 feet per minute; feed, 8½ inches per minute; depth of cut, 3-32 to ⅛ inch.

[Several other illustrations were given, of pieces milled with formed cutters, or having several operations, with more than one cutter, which cannot well be summarized.—Editor.]

STEAM TURBINES COMPARED.

From paper by A. R. Dodge, read before N. E. Cotton Mfrs. Assoc. (Mr. Dodge represents the Curtis Turbine.)

One of the earliest efficient turbines of practical form was brought out by De Laval, and consists of a single combination of nozzles and a wheel attached to the shaft, carrying the vanes on its periphery.

The transformation of pressure into velocity in the nozzle is complex, but highly efficient. The steam at the area of smallest cross section, called the throat, always has a pressure about 58 per cent. of the initial and a velocity of 1,500 feet per second, unless reduced by a higher back pressure, at the discharge end of the nozzle. If a greater velocity is desired, the cross section at the throat is not changed, but the area of nozzle discharge is increased. We have, therefore, a means of obtaining any desired velocity entering the vanes by throttling the nozzle-end pressure, if less than 1,500 feet is desired, and by nozzle expansion if a greater velocity is essential. With this type a high velocity of the moving vanes is essential.

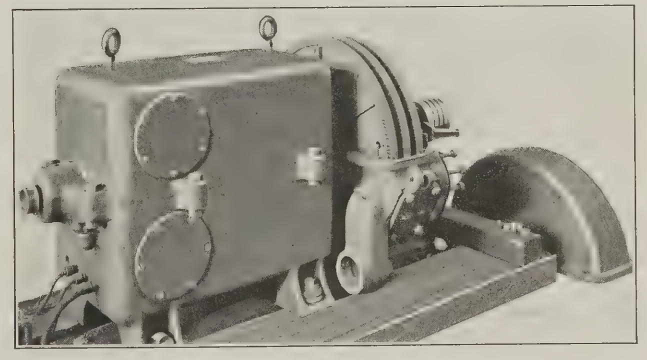


Fig. 1. Small Curtis Turbine and Generator for Train Lighting.

An initial pressure of 150 pounds will give a jet velocity of about 4,000 feet per second, if expanded to 28 inches vacuum. The vanes must therefore rotate at a speed of about 2,000 feet per second to abstract the maximum energy, a speed limited by the strength of material. About 1,200 feet per second is realized in practice, therefore this type is better adapted for a smaller range between initial and final pressures. A peripheral speed of 1,200 feet per second with this form of wheel necessitates the use of a flexible shaft and special gearing.

The Parsons machine was brought out shortly before the De Laval, and has much lower velocities of steam and vanes, and the process of transforming pressure into work must be repeated many times, entailing a large number of successive revolving rows of vanes with stationary rows of vanes between each. As there is considerable drop in steam pressure between the entering and discharging sides of the revolving vanes, owing to small clearances, an unbalanced pressure acts on the vanes. This results in a serious end thrust, which is reduced by making the drum carrying the vanes of small diameter, thereby increasing the revolutions per minute and the difficulties of generator design, as gearing is not used.

Many of the vanes must therefore rotate in steam of high density, and there is considerable brake action between vanes and outer shell due to water of condensation. Both of these losses are reduced by superheat. The large number of vanes, about 31,000 in a 300-kilowatt set, are inserted by hand, and the longer ones held at the outer end by supporting wires, to which the vanes are soldered.

The Rateau type is similar to the De Laval, except that the combination of nozzles and single wheel is repeated several times, with less expansion during each process than in the earlier turbines. A space is given for the steam discharged from the revolving vanes to utilize its energy in the form of velocity by evaporating part of the moisture, and start the process of fractional abstraction anew in the following nozzle. A single wheel per nozzle, or group of nozzles affords a minimum change in the direction of the steam jet at high velocity and shortens its opportunity to diverge, before a following nozzle again brings it into line.

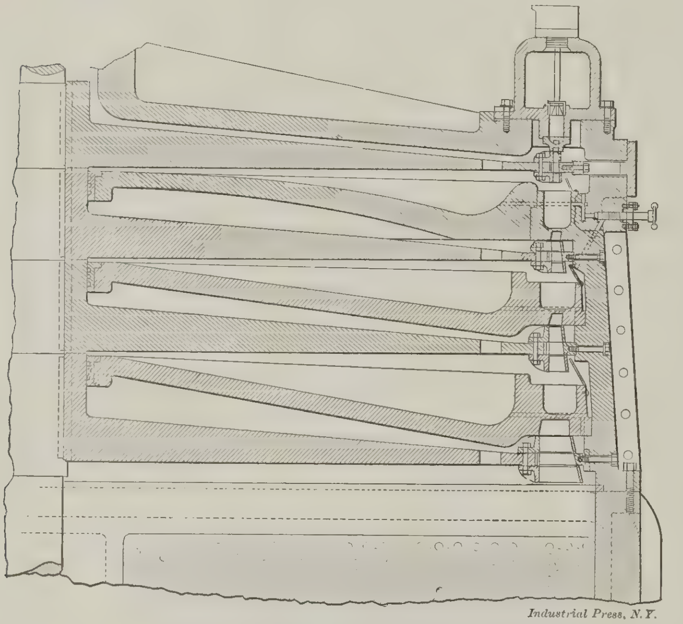


Fig. 2. Sectional Elevation of one-half of Curtis Turbine.

The outer clearance is small and the buckets have no outer band like the De Laval, but as steam is admitted only in sections of the periphery, end thrust is eliminated as the pressure on each side of the disk tends to equalize through the empty vanes.

The cylindrical clearance space between each intermediate nozzle and revolving element is near the shaft where the clearance can be made a minimum. This greatly increases the area of stationary nozzle surface near the revolving elements and adds to the loss through friction. As in the Parsons type, many of the wheels revolve in steam of high density and the friction caused by water of condensation is considerable. A print of this turbine, recently published, shows twenty-five wheels and twenty-five sets of directing nozzles. Proper adjustment of these twenty-five clearances with variable shaft temperatures, leaves much to be desired as to simplicity.

Still another type is that brought out in this country by Mr. Curtis, which in addition to nozzles delivering steam at high velocity to a single wheel has also stationary vanes which redirect the steam discharged at considerable velocity from the first wheel, due to the relatively low bucket speed, into the second wheel. The velocity of the jet leaving the nozzle is about 2,000 feet per second, about half the velocity of the De Laval under the same conditions of exhaust pressure, while the peripheral speed of the vanes in the Curtis is proportionally much less, about 400 feet per second, instead of 1,200 feet per second. By this process of fractional abstraction the speed of revolving vanes need not be excessive to secure maximum economy, in other words to bring the direction of the jet discharged from the last set of vanes parallel to the shaft. With this high-steam velocity comparatively few revolving vanes are necessary, and they rotate in steam which has a lower density, due to the considerable drop in pressure from one stage to the next. There is a large clearance between outer wall of revolving vanes and the shell, reducing friction due to water of condensation. End thrust is eliminated, as there is abundant opportunity for the pressure to equalize on each side of the revolving disks, and the entrance and discharge angles of the vanes are the same.

A still more recent type, the Stumpf turbine, has a single rotating element with buckets cut in the solid disk, which is made of nickel-steel, and operates with a rim velocity of 1,200 feet per second, and a low shaft speed, reduced by the large diameter of the disk. The centrifugal forces are very high, but a factor of safety of five is guaranteed.

The vanes are cut similar to those of the Pelton water wheel and the jet is directed against the wheel in much the same way. The wheel is sufficiently wide to allow two rows of vanes. Steam enters one of these sets of vanes, which abstracts a fraction of the velocity, flowing in the direction of the shaft to the edge of the wheel, and is then carried over to enter the vanes on the other side of the wheel by a stationary vane.

The following table embodying approximately the velocities of turbines of 300 kilowatts to 500 kilowatts capacity will aid in this comparison:

	Rows of Rotating Bucket Rings.	Steam Velocity feet per second.	R. P. M	Peripheral Speed	Buckets.
Parsons.......	35	400	3,600	200	inserted
Rateau........	25	800	2,400	400	inserted
Curtis.........	8	2,000	1,800	400	solid
Stumpf........	1	4,000	3,000	1,200	solid
De Laval......	1	4,000	20,000	1,200	inserted

Each type has its characteristics and the advantages of one over another will depend largely on the cost of construction, reliability, and improvement in efficiency.

* * *

A correspondent of the *Railroad Gazette* suggests a solution of the alleged vexing confusion in the use of the word "engineer" in this country. In England and on the Continent, the term "engineer" means a member of a learned profession; here it means both the learned gentleman and the greasy "gent" who pulls the throttle of a steam engine, which, of course, is supposed to materially detract from the dignity of the aforesaid gentleman. In England a locomotive "engineer" is a "driver" and a stationary throttle-puller is an "engineman" or "machinist." Mr. Szlapka would substitute the word "ingeneer" for "engineer" when it is applied to the professional man, thus: *Henry Szlapka, Consulting Ingeneer.*

* * *

The moving picture machine is now being used not only for the purpose of amusement, but for business as well. An instance is that of a new car fender that is being exploited by the aid of a portable mutoscope, which the salesman can carry about with him to capture the attention of the busy street railway manager, and at the same time make an impression that otherwise would be quite impossible. The views show a practical test of the fender on a living subject, the fender picking him up without injury when running at a speed of about 22 miles per hour. The views, taken in Brooklyn, show the car rapidly approaching the victim, the "accident," his position in the fender and final rescue uninjured. The scheme for selling the appliance is not less wonderful than the device itself.

CUTTING FRACTIONAL SCREW THREADS.

FRED H. COLVIN.

Thread cutting is always an interesting problem and the question of change gears is one that comes up every day in the shop. The gear tables show what to use for a regular thread but when it comes to fractional threads many are all at sea. Then they want a book or a table that will show just what they wish to know without any figuring. But they forget that there is almost no uniformity of practice among lathe builders and that leadscrews vary, as well as the "jumps" between change gears; some go by 4 teeth, some by 5, etc. Then, too, there are ways of "doubling up" in the head, by putting in a compound or back gear out of sight in the headstock.

The first thing to do in any case is to find out the exact ratio between the spindle and the leadscrew, which might be called the "constant" for the lathe. This could be defined as the ratio between the gears required to move the carriage one inch for every revolution of the spindle. It might be suggested that this could be the ratio between the gears which would cut the same thread as the leadscrew, but for fractional threads the former is the better and will cause less confusion. If there are no multiplying gears (which would be equivalent to putting the first gear on the lathe spindle) the teeth in the spindle or first gear will be as many times those of the leadscrew gear as the leadscrew has threads per inch. Thus, with a 6-pitch leadscrew the screw must turn 6 times to move the carriage an inch. But as is often the case, it may be found that with even, or similar gears, the lathe would cut a 3-pitch, or only require 3 turns of the leadscrew to move the carriage an inch. This shows there is a multiplying gear in the head, such as a 48 on the spindle, driving a 24 on the stud which takes the first change gear.

For practical use, find the equivalent pitch of leadscrew by putting even gears on both stud and screw, and find what thread would be cut. It may be that a 48 gear on spindle drives a 32 on the stud, when the screw will be equivalent to a 4 instead of a 6. Then to cut a 12-pitch thread multiply both 4 and 12 by any number that will give gears upon the gear list. Multiplying by 5 gives 20 and 60. If these gears are not at hand, try multiplying by 4½, which gives 18 and 54. To cut 11½, multiply by 8, giving 32 and 92. Probably there will not be any 92 gear so a 46 may be used on the screw and a 2 to 1 multiplying gear put on the compound stud. If these gears cannot be had, try some multiplier which will give gears that are in stock. 4 times 4 = 16 and 4 × 11½ = 46, so that a 16 will do, but it is smaller than is usually found. Six gives 24 and 69 and the latter is an odd gear but may be supplied for cutting this thread.

For cutting threads expressed in pitch to the inch this is the easiest way, but for pitches expressed in inches it is apt to be confusing, and for this reason it is better to consider the leadscrew in inches rather than threads per inch. A 4 pitch leadscrew would then be ¼ — a 2 pitch ½ etc., always remembering that the leadscrew is considered at its equivalent pitch, or the distance it moves the carriage for one revolution of the lathe spindle. Taking the leadscrew as ¼ inch pitch and having to cut a screw which measures ¾ inch from thread to thread we readily see that the leadscrew must make 3 turns to one of the spindle. Consequently the gear on the stud must have 3 times as many teeth as the gear on the screw. Putting this in example form we say: ¼ is to ¾, as the gears that we are to use. The ¼ is the leadscrew gear and ¾ the stud gear. As they both have the same figure below the line (denominator) we only consider the figures above, which are 1 and 3. Multiplying both by 20 we have 20 and 60; or by 24, we get 24 and 72. Either of these gears paired as shown will cut the thread.

Still keeping the ¼-inch pitch leadscrew—and we will keep this during all the calculations—we have a piece of work requiring a thread with a 13-16-inch pitch, or ¾ and 1-16 as some say. Now, while this looks like a puzzler, it is easy if we keep cool and do a little thinking. As the pitch desired is in 16ths of an inch, reduce the leadscrew pitch to same terms and ¼ = 4-16. Then we can neglect the denominators and only consider 13 and 4. As the desired pitch is faster than the leadscrew, the leadscrew must be turned faster than the spindle, so the large gear goes on the stud. Multiply 13 and 4 by any number that will give gears that are in stock. Multiplying by 4 gives 52 and 16, by 5 gives 65 and 20, and by 6 gives 78 and 24, any of which will answer the purpose.

Another puzzle is when the foreman calls for a thread making one turn in an inch and seven-sixteenths, or 1 7-16 pitch. As we usually think of a thread as being less than an inch pitch this might easily puzzle one who isn't used to it. But we simply reduce the fraction to 16 + 7 = 23-16 and the leadscrew to 4-16 and then forget the 16s entirely, so this is 23 and 4. Multiplying by 6 gives 138 and 24. But 138 is larger than most lathes possess, so we must compound. A 2 to 1 compound would give 69 for the large gear. Many lathes would not have this gear, so if we can compound 3 to 1, divide 138 by 3 and get 46 for the large gear.

Still another way to get stuck is to have the pitch given as ¾ of a turn to the inch. This isn't ¾-inch pitch but a pitch faster than one per inch. As there must be 4-4 to the thread and only 3 of these take place in one inch it is clear that ¼ of the pitch must take 1-3 of an inch so that the whole pitch must be 1 1-3 or 4-3 inch. With the same leadscrew of ¼-inch pitch we must reduce the fractions to the common denominator which will be 12. Then 4-3 = 16-12 and ¼ = 3-12 so we have a ratio of 16 to 3. Multiplying by 6 gives 96 and 18 as gears that will cut this. One more example of this kind may help. Call this 7-16 of a turn to the inch. As there are 9-16 more to the thread it must move 1 2-7 inches for the balance. This makes the pitch 2 2-7 inches or 16-7. Then with leadscrew ¼ we must reduce them to same fraction. The lowest common denominator is 28 and this gives 64-28 and 7-24 or 64 to 7, a large ratio. Multiplying by 4 gives 256 and 28 which will probably require compounding at 4 to 1 if it can be done. This would give 64 to 28 as the right gears.

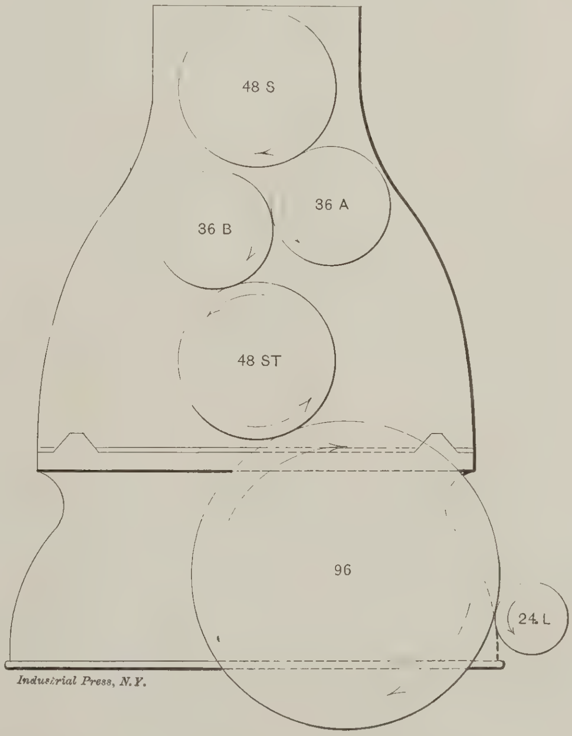


Diagram of End of Lathe, showing Gearing.

Fractional pitches are not nearly as hard as they look if one goes at them slowly and follows directions. To make this more complete and satisfy those who want tables, the writer has calculated the two tables which follow. But before giving them it is necessary, or at least desirable to go to the root of thread cutting, so that they will not be wrongly used and then blamed for mistakes which may be made. To help make this clearer the end of the lathe with its gears is shown in outline. This is only one of many arrangements but it will serve the purpose. The lathe spindle has a 48 toothed gear which drives one of the two smaller gears shown. The arrows show direction. The 48 toothed gear below carries the stud on which the change gears are placed, but to avoid confusion, the large intermediate gear is shown driven directly by the 48 tooth gear. The leadscrew carries a 24 tooth gear, as shown.

This is a good place to emphasize the fact that the only gears that need be counted in a simple train are the driver and the driven, or the first and the last. The intermediate gears do not count *unless compounded*, but this will be explained later.

First consider the lathe head only or the gears from the spindle to the stud, including both. The spindle carries a 48 gear. In one revolution this will drive the next gear 48 teeth. No matter about revolutions now—these don't count till we come to the driven gear—the last of the train. Each gear moves 48 teeth every time the driver makes one revolution and as the gear on the stud—the last of this train—has 48 teeth it moves 1 revolution. In other words, they are "geared even." The intermediate gears marked 36A and 36B are merely for reversing the direction of the leadscrew or for cutting it out altogether. The gears move so that both *A* and *B* can be out of mesh with the spindle or that *B* drives. In this case gear *A* simply runs idle. If the gear driving the stud *ST* had 96 teeth it would turn half as fast as the spindle and make it necessary to consider the leadscrew half the actual pitch. This is the "true" or "equivalent" pitch considered in the tables. This is sometimes done in building lathes and, as will be seen, confuses anyone who attempts to figure gears with an iron-clad rule and doesn't look at the ratios of the spindle, stud and leadscrew. Returning to the cut and calling the stud 48, we realize that this will drive the large gear 48 teeth (no matter what part of a revolution) and in turn drives the last gear the same number of teeth. As this last gear has 24 teeth, it will make two revolutions, and cut a thread double that of the leadscrew.

EQUIVALENT OR TRUE PITCH OF LEADSCREW.

Pitch in inches.	2	3	4	5	6
	S. L. S.	S. L. S.	S. L. S	S. L. S.	S. L. S.
5/16 inch.	20 — 32	30 — 32	30 — 24	50 — 32	60 — 32
	25 — 40	75 — 80	25 — 20	125 — 80	75 — 40
3/8 “	24 — 32	36 — 32	36 — 24	60 — 32	54 — 24
	30 — 40	45 — 40	30 — 20	75 — 40	45 — 20
7/16 “	28 — 32	42 — 32	42 — 24	70 — 32	84 — 32
	35 — 40	105 — 80	35 — 20	175 — 80	105 — 40
1/2 “	24 — 24	36 — 24	48 — 24	80 — 32	72 — 24
	25 — 25	30 — 20	40 — 20	60 — 24	60 — 20
9/16 “	36 — 32	54 — 32	54 — 24	90 — 32	108 — 32
	45 — 40	125 — 80	45 — 20	225 — 80	135 — 40
5/8 “	30 — 24	60 — 32	60 — 24	100 — 32	90 — 24
	25 — 20	75 — 40	50 — 20	125 — 40	75 — 20
11/16 “	44 — 32	66 — 32	66 — 24	110 — 32	132 — 32
	55 — 40	165 — 80	55 — 20	275 — 80	165 — 40
3/4 “	36 — 24	72 — 32	72 — 24	120 — 32	108 — 24
	30 — 20	45 — 20	60 — 20	90 — 24	90 — 20
13/16 “	52 — 32	78 — 32	78 — 24	130 — 32	156 — 32
	65 — 40	195 — 80	65 — 20	325 — 80	117 — 24
7/8 “	56 — 32	84 — 32	84 — 24	140 — 32	126 — 24
	35 — 20	105 — 40	70 — 20	105 — 24	105 — 20
15/16 “	60 — 32	90 — 32	90 — 24	150 — 32	180 — 32
	75 — 40	255 — 80	75 — 20	375 — 80	225 — 40
1 1/16 “	68 — 32	102 — 32	136 — 32	......	......
	85 — 40	225 — 80	85 — 20	......	......
1 1/8 “	72 — 32	108 — 32	108 — 24	......	......
	45 — 20	135 — 40	90 — 20	......	......
1 3/16 “	76 — 32	114 — 32	104 — 24	......	......
	95 — 40	......	95 — 20	......	......

Table No. 1.

If now, instead of running the large gear in mesh with the 48 *ST* gear, we put a 24 gear beside it, and drive the large gear from that, we have compounded the gears. While *ST* moves 48 teeth, the large gear is only driven 24 and the leadscrew makes one revolution. If on the other hand, we put a 96 on beside the *ST* gear, we will compound the other way and drive the leadscrew four revolutions to one of the spindle.

It is sometimes difficult to see the gears in the head but it is easy to put "even" gears on both stud and leadscrew and see what thread is cut. This is the true leadscrew pitch and should be used in all calculations rather than the actual pitch. In the tables that follow, gears have been used that are usually found on lathes, although in some cases it has not been possible to do so. Two combinations are given in most cases, one using gears which vary by 2 or 4 teeth and the other by 5 teeth. Where very large gears are called for, it will usually be found necessary to compound between the stud and leadscrew. Take, for example, the pitch of 11-16 inch with a 4 pitch leadscrew. The gears are 136-32. If now we compound so as to double the speed of the leadscrew, it becomes equivalent to a 2 pitch and a 68 gear on the stud does the same work. The tables are accurate if used as intended—but care must be taken to avoid mistakes.

EQUIVALENT OR TRUE PITCH OF LEADSCREW.

Threads to inch.	2	3	4	5	6
	S. L S	S L S.	S. L S.	S L. S.	S. L. S.
11½	24 — 138	24 — 92	32 — 92	20 — 46	24 — 46
	20 — 115	30 — 115	40 — 115	50 — 115	60 — 115
5½	24 — 66	24 — 44	32 — 44	20 — 22	24 — 22
	20 — 55	30 — 55	40 — 55	50 — 55	60 — 55
4½	24 — 54	24 — 36	32 — 36	40 — 36	48 — 36
	20 — 45	30 — 45	40 — 45	50 — 45	60 — 45
3½	24 — 42	24 — 28	32 — 28	40 — 28	48 — 28
	20 — 35	30 — 35	40 — 35	50 — 35	60 — 35
2½	24 — 30	24 — 20	32 — 20	40 — 20	48 — 20
	20 — 25	30 — 25	40 — 25	50 — 25	60 — 25
1½	32 — 24	48 — 24	64 — 24	80 — 24	96 — 24
	40 — 30	60 — 30	80 — 30	100 — 30	100 — 25

Table No. 2.

The tables do not by any means show *all* the gear combinations that will cut given threads, only two of the combinations most likely to be found. No gear below 20 is used. As an example of what might be done take 7-16 inch pitch and leadscrew of 2 pitch. This reduced to inches gives 7-16 and ½ inch or 7-16 and 8-16 or a ratio of 7 to 8, the 7 for the stud and 8 for the leadscrew. Multiply both of these by any number and get any gears that can be used, such as:

S.	L. S.	S.	L. S.
21	24	49	56
28	32	56	64
35	40	63	72
42	48	70	80

And by compounding, a much larger variety may be obtained.

Just remember that the whole question is simply the number of revolutions of the leadscrew as compared with the spindle, or the distance the carriage will be moved by one turn of the spindle, and no trouble will be experienced.

* * *

MOLDING WITHOUT PATTERNS.

An interesting article by Mr. Henry Hess on floor molding without patterns, appeared in the October issue of the *Foundry*, which is based on the writer's experience while connected with the German Niles Tool Works at Berlin, Germany. The article illustrates how floorplates, lathe beds, large faceplates, etc., were molded without the use of patterns. Of course dry sand cores play a leading part in such work, units being joined together to form the complete mold in much the same manner as has been practiced for several years in the country in the casting of medium heavy flywheels. Molding flywheels in this fashion as practised by Jones & Laughlins, Pittsburg, Pa.; Struthers, Wells & Co., Warren, Pa.; Geo. V. Cresson Co., Philadelphia, Pa., and others, requires a pattern of one section only, by which is meant one spoke and such a portion of the arc of the hub and rim as is expressed by 360 degrees divided by the number of spokes. Dry sand "cores" are made from the pattern, and when assembled, of course, inclose a cavity of its shape. If there are eight spokes in the wheel, the complete mold will consist of eight of these cores arranged in a circle, thus forming a complete hub and rim. Jones & Laughlins have a large flywheel cast in one piece by this process, which has been running for a number of years at a peripheral speed of nearly two miles a minute.

* * *

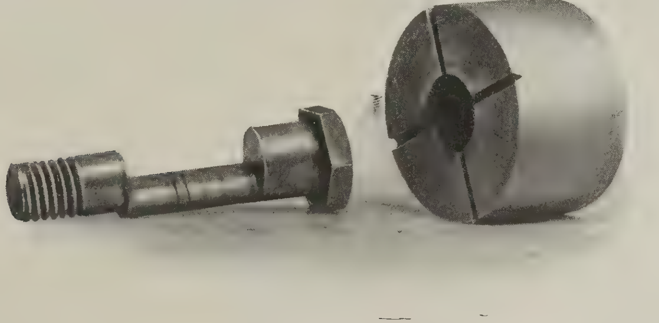
A subscriber is building a special machine in which it is necessary to have certain iron parts covered with canvas and wishes the receipt for a cement which will stick the canvas securely to the iron. If any readers have had experience with such a cement we should be glad to receive directions for making it.

LETTERS UPON PRACTICAL SUBJECTS.

A SLIGHTLY (?) WORN ROLLER PIN.

Editor Machinery:

The accompanying cut shows a cam roller and pin as they were recently removed from a machine in which they had been in use for about eight months. They had been causing trouble for some time and an examination by the master mechanic revealed the condition of affairs here shown. It was found that the rollers had been made from tool steel and hardened, while the pins were of machinery steel which was not hardened. As will be seen in the photograph, a series of grooves have been cut by the workman in each end of the roller for the purpose of admitting oil to the pin. This had the effect of causing the roller to act as a milling cutter and the pin was cut smooth and true on each side of the portion that was worn down. As the chips had no way of escape, the roller being held in a forked lever, they were carried in with the oil and helped to grind the pin down, thus throwing the machine out of order.



Cam Roller and Worn Pin.

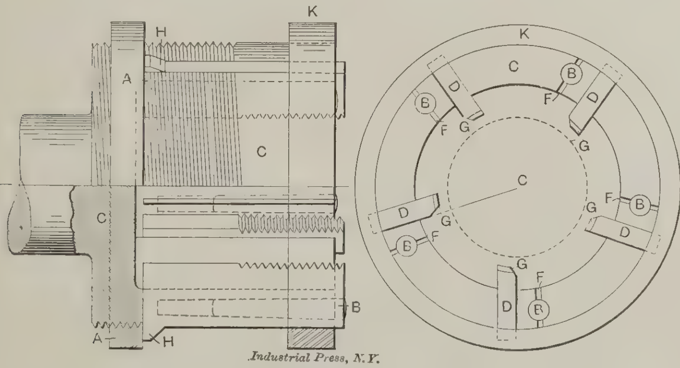
Two lessons may be learned from this experience: First, to follow the specifications given on the drawing, which in this case called for both pieces to be made of tool steel and hardened; second, not to cut oil grooves in the ends of a roller.

Port Chester, N. Y. A. D. Finley.

A LARGE DIE FOR CAST IRON.

Editor Machinery:

The accompanying sketch shows a die, made by the writer, which has been used with considerable success for threading large cast-iron work. *C* is a collet which holds the dies *DD*. A short distance in front of the slots in which the dies fit, are a series of smaller slots, *FF*, in the center of which are placed taper pins, *BB*. When the dies have been put in place these pins are driven in firmly and, expanding the slot, they cause the die to be held tightly in position. A ring, *K*, is placed around the outside of the collet to prevent the dies from spreading out. On the back end of the collet is screwed a ring, *A*, and the ends of the dies, terminating in the shoulders, *H*, bear against this ring. As the die becomes dull the ring is screwed further on and the blades are thereby pushed forward so that their front ends may be ground off until a sharp thread is reached. In this way the blades can be used for almost their entire length and, when completely worn out, it is a comparatively simple matter to supply the holder with a new set of cutters.



Die for Large Cast Iron Work.

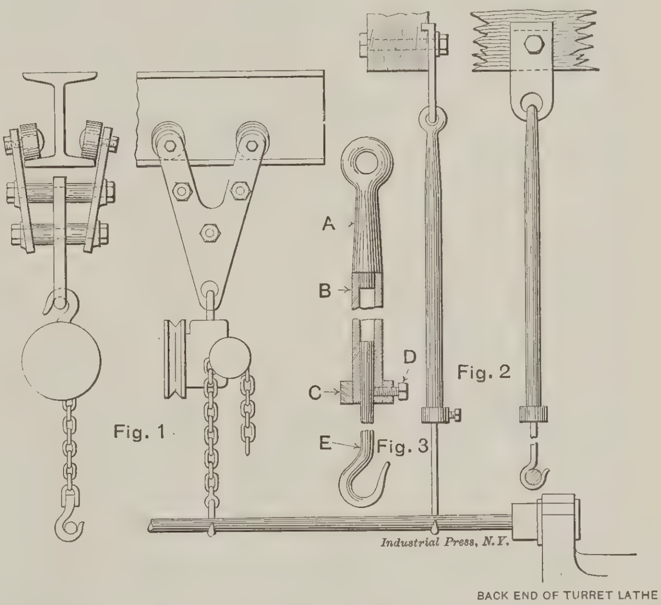
It will be seen in the sketch that the front side of the die is in line with the center of *C*. When the dies were first made they would not work at all, but when the corners had been ground off, as at *G*, they worked very well except on some castings which seemed to be of unusually difficult iron to cut. I would like the opinion of some of the readers of Machinery as to whether I have followed the right course in constructing the die in this way, or should the cutters have been set forward of the center? Dies of this class may be profitably employed quite frequently, and if any one can suggest an improvement, or point out any error in regard to the position of the cutters, the information will, without doubt, be of interest to others as well as to the writer.

Cedar Rapids, Iowa. M. E. Sanders.

ADJUSTABLE HANGERS AND SUPPORTS FOR USE WITH TURRET LATHES.

Editor Machinery:

Almost any one who has had much to do with the handling of bar stock on the screw machine or the turret lathe, is familiar with the troubles common to the forked support or rest generally used, and cannot fail to realize the heavy strain imposed upon a man when using large stock; to say nothing of the noise and rattle that accompany the revolution of a 2-inch iron or steel bar, 16 feet long, when the rest is a little too high or too low. Additional strain is also put upon the man when he is, every now and then, required to move the heavy standard to accommodate the length of the bar.



Stock Supports and Hangers.

Figs. 1 and 2 show two types of stock carriers that will be found to greatly lessen this trouble and incidentally save considerable time owing to the ease and quickness with which stock can be handled with their aid. Fig. 1 shows a chain hoist attached to a small traveling carriage which moves upon the lower flange of an I-beam that is fastened to the floor timbers above the machine. Fig. 2 shows an adjustable support that is fastened to a beam just above the end of the lathe. This same style of support may also be attached to the traveling carriage in place of the chain hoist. With a traveling support of this kind, one man alone can readily take a bar of the largest stock from the rack, run it up to the machine, slip one end through the fixed support and place the bar in the machine. The chain hoist, however, will be found most convenient as it enables the operator to easily lift the stock from the floor.

The construction of the adjustable hanger is shown in Fig. 3. On the end of eye, *A*, is forged a piece of wrought iron pipe, *B*, of any length required to suit the height of the beam above the machine. A collar, *C*, is shrunk onto the lower end of this pipe and through it is passed the setscrew, *D*, which holds the hook at any desired height. The hook, *E*, slips up inside of the pipe and if marks be made upon it where it enters the pipe, it can be readily adjusted in height to suit any size of stock.

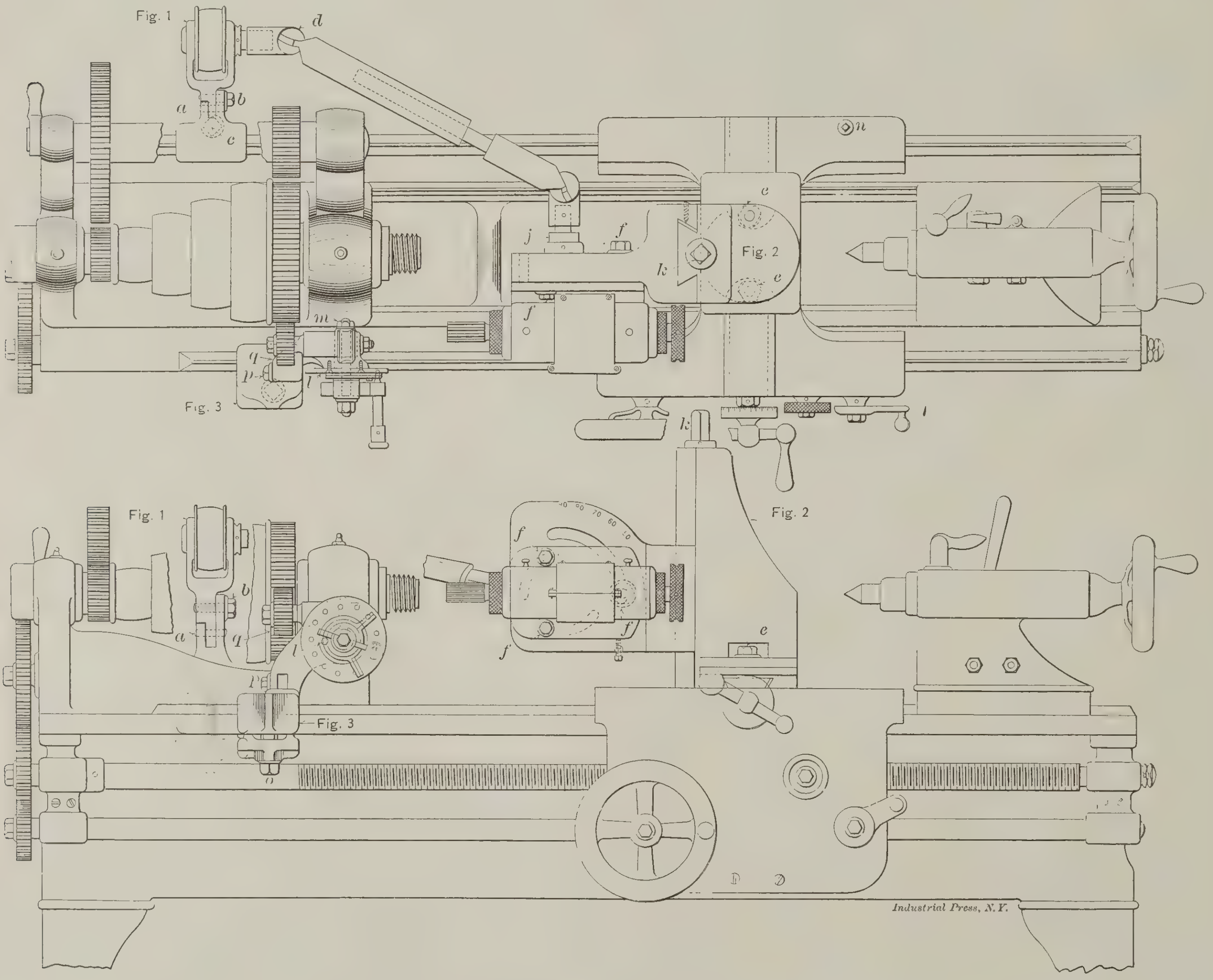
A convenient arrangement, where stock is to be supplied to several machines, is to furnish each machine with one stationary, adjustable support and one adjustable support on a traveling carriage, then one carriage with chain hoist can be used to bring stock up to any of the machines desired, and as soon as it has been placed in the supports belonging to that particular machine, the hoist may be removed and used elsewhere.

C. NEIL.

A MILLING ATTACHMENT FOR THE LATHE.

Editor MACHINERY:

It frequently happens that it is desired to take a milling cut on a piece of work while it is still held upon the faceplate of the lathe upon which it has been turned. In order to do this the attachment illustrated in the drawing herewith will be found very convenient. While the arrangement here shown may be still further improved, this one has already proved very satisfactory for any kind of work that has been attempted upon it. With the three attachments in position as shown, all that is necessary for the operator to do is to attend to the indexing of the work around to its lines of measurements. These attachments are especially useful for milling circles, circular slots, etc., in plain or irregular pieces. When in use they are bolted securely to the lathe and can be adjusted to any desired position. One point of advantage that will be noticed in connection with these attachments is that it is unnecessary to change the construction of the lathe in any respect, as they require no holes or other alterations that would in any way impair the efficiency of the lathe. They are quickly attached and easily adjusted, and as they are driven from the lathe itself no extra countershaft is required.



Industrial Press, N.Y.

A Milling Attachment Applied to the Lathe.

The milling spindle is driven through bevel gears which are connected by telescopic rod and universal joints to the driving attachment shown at Fig. 1. The driving attachment is operated by a belt which runs over any step of the lathe cone that is calculated to give the required cutting speed to the milling cutter. When the milling attachment is being used the cone locking bolt is thrown out so that the cone runs free on the lathe spindle, and as the cone may be driven on any step and the driving attachment may be driven from any other step the range of milling speeds is consequently very wide.

The driving attachment consists of a pulley which is held in a forked bearing. This fork is hinged to a base *c* in such a manner that it may be set at any angle and when so set is firmly clamped by the bolt *b*. The base itself may be clamped at any position along the bed of the lathe by means of the clamping bolt *c*. The fork is hinged about the pin *a*, while the bolt *b* moves through a slot which allows a movement of the pulley of 5 inches, so that the different lengths of belt caused by employing different steps of the cone, may be kept at proper tension. The universal joint *d*, by which the driving attachment is connected with the milling attachment, is capable of working to an angle of 70 degrees.

The milling attachment proper is fastened to the cross slide of the lathe by the two screws *ee* and in no way interferes with the use of the lathe for ordinary purposes. The cutter head is pivoted so that it can be set at any angle from horizontal to vertical and graduations are provided for indicating the angle. It is clamped in position by the three bolts *fff*. In addition to this movement the cutter head has a movement of 7 inches up and down on the face of the column upon which it is mounted, being operated by the screw *k*. These combined movements allow the operator to bring the cutter to bear upon the work in the most advantageous positions. The spindle is very large and formed to receive collets, drill chucks, milling cutters, etc.

The fixture shown at Fig. 3 is for the purpose of indexing the work on the spindle of the lathe. The base of this indexing attachment is clamped to the bed of the lathe by the screw *o* and is provided with a swivel joint similar to that used on the driving attachment, so that the gear *q* can be meshed with the spindle gear or thrown back out of mesh without disturbing the arrangement in any way. Mounted upon the swinging arm is the shaft bearing the gear *q* and having at its opposite end a worm wheel which meshes with a worm mounted on the indexing shaft. The indexing shaft passes through the plate *l* and terminates with an index pin. By the use of this attachment any desired divisions of the circle may be made upon the work as in the regular milling machines.

New Haven, Conn. A. L. Monrad.

ECONOMICAL BOILER SETTINGS.

Editor MACHINERY:

I noted the criticism of "J. A. P." in the letters of the August issue, and as this is an interesting subject, further discussion of it seems to be in order. He says that the pit in rear of the bridge wall should be filled up in order that the gases may be more thoroughly burned, but his conclusion is not logical. We are told that a large, high furnace is necessary to secure combustion of the fuel, also that we must have a large chamber at the rear for the combustion of gases—all of which seems proper. Then why must we have a small passage behind the bridge wall to secure the same result?

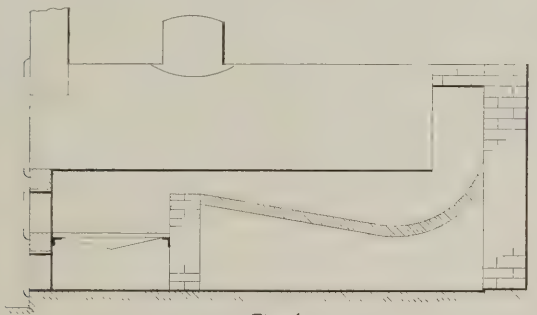


Fig. 1

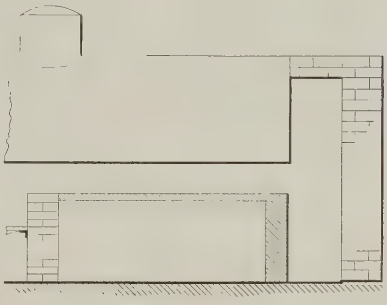
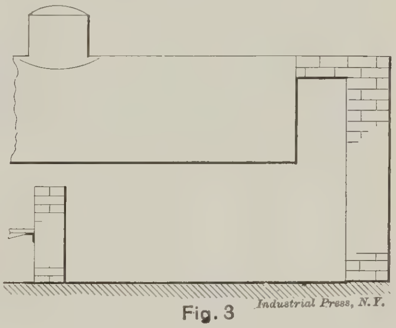


Fig. 2



Industrial Press, N.Y.

Fig. 3

He mentions a battery of three boilers, two of which gave good results, but the third was less efficient. After a while the third did better work because the space back of the bridge wall filled with ashes, making what he calls a better combustion chamber. I should like to know what method was adopted to determine the efficiency of the third boiler. If the steam was discharged into a main common to all of them, was not the increased efficiency due to the imagination of the engineer in charge, or was a careful test made to determine it? How long was this boiler run before its efficiency increased? Under ordinary conditions it would take about three years for the space to fill with ashes, so as to equal the ordinary method of filling in this space; therefore if the efficiency was really increased within a few months, it was due to some other cause.

A certain engineer had charge of a battery of 10 small tubular boilers. Three of them were taken out and replaced by two larger ones. He had the bridge walls built in the form of an inverted arch, only 4 inches distant from the shells. As the products of combustion were forced through this narrow space the heat was intense at this point, doing the shells no good to say the least, but he always claimed that this plan saved much coal. As the whole battery of 9 boilers discharged their steam into one main it was impossible to tell which boiler was the most efficient, so far as I could judge, and he never could give a reason for his belief; therefore it was an open question, in my opinion, and the same reasoning applies to the third boiler mentioned by "J. A. P."

He mentions another "set of boilers," but does not state the number, in which a saving of 500 pounds of coal was made in 24 hours, by filling in behind the bridge walls. If there were 5 of them it means 100 pounds each, or 40 pounds for an ordinary run of 10 hours. This amount is so small that it would take a long time to pay for the brick work, etc., required, especially when the extra cost of more frequently removing the ashes is considered. Were any other changes made at the same time? What measures were taken to know exactly the amount of water actually evaporated both before and after the change?

If these boilers were of 100 horse power each, and 9 pounds of water were evaporated by each pound of coal, the saving mentioned amounts to but 36 pounds of water per hour for each boiler, and if tests were so carefully made that it is known beyond dispute that this small saving was due to the change mentioned, said tests were of a very superior order, as there are many other things to be considered, any one of which would make more difference than he reports.

While investigating this matter I compared the results of several tests made on boilers that are practically alike, except a difference in the setting. I found reports of five tests made on boilers set as shown in Fig. 1. The average of these is 9.73 pounds of water evaporated per pound of combustible, from and at 212 degrees, which is a proper standard for comparison. Four tests were made on boiler set as in Fig. 2, the average of which was 10.97 pounds. Five tests were made with the setting illustrated in Fig. 3, and the average was 11.28 pounds of water. In one case the pit behind the bridge wall was 7 feet deep. These figures, which were taken in an impartial manner, show results in favor of a large combustion chamber behind the bridge wall, and this seems logical in view of the large space required in the furnace, and at the rear end of boiler.

Many years' experience with this type of boiler satisfies me that it is better to have the space at this point so large that it will not get half full of ashes in a year, than to have it small, making it necessary to clean it out every three months, especially if the rear end of boiler setting is within a yard of a nice engine room door, as in the case of my present plant. We can stand one such job each year, but do not want it every quarter. The lower half of a boiler shell can be inspected and repaired much easier and better, where there is room to do it, than where the space is but a few inches deep, and our boilers are not accessible enough at present, therefore all useless incumbrances should be dispensed with. W. H. Wakeman

New Haven, Conn.

[In reply to the above letter we have received the following communication from "J. A. P.," in which he answers the questions raised by Mr. Wakeman.—Editor.]

Editor MACHINERY:

Relative to the remarks by Mr. Wakeman, concerning the suggestions on boiler settings which were offered by me in the August number of MACHINERY, I would say that they were the evidence of practical experience rather than a comparison of efficiency tests, and the conclusions drawn were not entirely original but followed out the idea of a number of able engineers of broad experience in the designing of boilers. It will be readily admitted that we need a large and roomy furnace, but it would be possible to make a furnace too large, and the same reasoning applies to the combustion chamber. Let us consult a few statements of leading engineers relative to the design of a furnace of the most economical type.

Mr. J. W. Shepard, in a paper before the Western Railway Club, makes the following statements, among others, on the subject of combustion: "Let it be said that coal, as such, does not burn. Before any burning can occur the coal must be broken down. The gases evolved are almost all hydrocarbons; these hydrocarbons must also be broken into their component parts, hydrogen and carbon. The real process of burning is the uniting of oxygen, a gas, with the fuel to be burned."

Now since all of the above statements are true, we have placed a limit upon the size of the furnace. As far as the breaking down of the coal is concerned it might be of almost any size, but when it comes to the gases we are limited, because when one atom of carbon unites with two of oxygen we get the best condition for burning, or for uniting the oxygen with the fuel. Since the air contains the oxygen used, we must have our furnace of such a size as will furnish as nearly as possible the required amount of air to supply the oxygen; a furnace abnormally large will contain more air than is necessary and will prove detrimental. Now since the combustion chamber does a large part of the work of decomposing or breaking down of the hydrocarbons into their component parts, and since this latter is a process of burning, we can get too large a combustion chamber as well as too large a furnace. The igniting temperature of hydrocarbons is from 940 degrees to 1,230 degrees, and we should have our combustion chamber up to at least this heat and keep it there. It is quite evident that a built-up combustion chamber is much warmer than a large open space back of the bridge wall. We are told that the ideal furnace is one in which the coal is burned separately from the boiler, only the heated gases being allowed to pass under the shell, and in the path of these gases we may erect pieces which, becoming highly heated, tend to increase the efficiency of the furnace. Now this is the idea of the built-up chamber; its bed is intended to be at the height of the lower strata of gases, or nearly so, and this becoming heated increases the efficiency of the furnace.

Mr. E. P. Parker, in writing upon the subject of smoke abolition, advocates a bridge wall three feet thick, making a combustion chamber of the bridge wall, in a sense. I find also in a design presented by him the built-up combustion chamber in addition to the thick wall.

Mr. G. B. N. Tower, formerly U. S. supervising inspector of steam vessels, presents the following suggestions upon boiler settings: "As gases are generated during the process of burning coal, suitable provision must be made to supply them with air necessary for their combustion. Now this air cannot be supplied through the grate bars, but must be supplied in the furnace above the fuel, and also *at and behind the bridge wall.*" Since air is to be supplied at the bridge wall, is it not far better to so design our combustion chamber that the air which enters shall be compelled to mix with the gases as much as possible, by limiting to some extent its permissible range of movement? This is the office of the built-up chamber.

The three boiler battery which was mentioned in my former article was not under a test, the facts of the case being as follows: When the installation was first made the whole battery was run for some time, then one boiler was dropped out and remained so for about six months. After this time it became necessary to run the third boiler again, and upon starting it up it was found that the first two boilers steamed faster than the third. The feed pipes were removed and cleaned and, as this was the only condition which could make an unequal feed, it was clear that the evaporative efficiency of the boilers which had been run regularly was greater for the reason before mentioned.

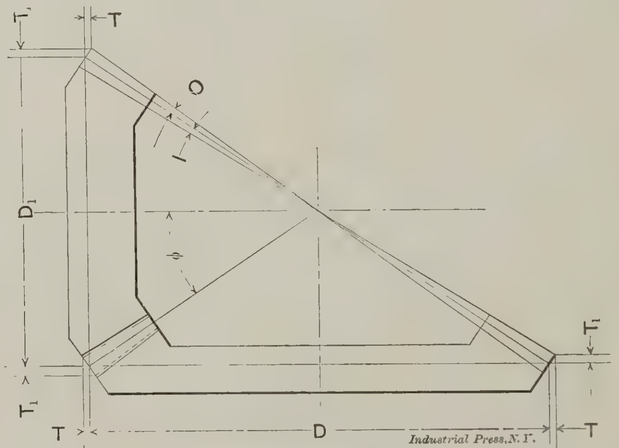
In regard to the other set of boilers mentioned it may be stated that there were two, not five. No efficiency test was made at the time, but they simply did the same amount of work after building in as before, and they used 500 pounds of coal less in twenty-four hours. Mr. Wakeman's water saving statement seems to be rather abstract in connection with this subject, as it was a saving of coal for which we were working, not water. We saved no water at all since the same amount of steam was used both before and after the change; we simply evaporated the same amount of water with less coal. Under a carefully-conducted calorimetric test these boilers showed an evaporation of 10.5 pounds of water per pound of coal. In connection with this test it may be well to say that the firing was not of the best, the fireman being somewhat inexperienced. In view of the fact that a run of these boilers before putting in the built-up chamber showed very poor steaming qualities it seems that the change was a decided improvement. With a properly designed combustion chamber there will be ample room for cleaning and inspecting the shell as well as for making repairs. The expense of a combustion chamber built in this way is very small since it requires only a double brick wall, about 5 feet long and 3 feet high, filled in with sand and covered over with brick. J. A. P.

BEVEL GEAR FORMULAS.

Editor MACHINERY:

It is doubtful if there is any other mechanism of equal simplicity that has called forth as many or as elaborate formulas as has the ordinary bevel gear. This fact appears more strange when we contemplate the simplicity of the essential calculations, and one is led to think that the matter has been slightly overdone. Instead of clearing up matters, this mass of formulas seems to have had a tendency to make the beginner regard the subject with more or less suspicion and dread. Then there is often the man of inquiring mind who would fain acquaint himself with the method of calculating bevel gears, but stands aghast when he finds that between him and the required goal there are a lot of trigonometrical expressions. He is willing to grapple with a few algebraic expressions but when it comes to trigonometry, he draws the line. That these expressions are not anywhere nearly as difficult as a great many are prone to imagine, goes without saying; but, on the other hand, are not these expressions injected into mathematical expressions unnecessarily?

For example: To find the maximum outside diameter of a bevel gear by the ordinary method, we take the ratio of the diameters, or numbers of teeth, and thus ascertain the corresponding center angle from a table of tangents. We then look up the sine and cosine of this angle and from these values and the pitch we obtain the required amounts to add to the pitch diameters of the gear and pinion respectively. This moreover is not as direct as it may seem, since the ordinary trigonometrical tables give only the function of angles varying by 10 minutes so that in most cases interpolation becomes necessary.



Industrial Press, N.Y.

Diagram of Bevel Gears.

In order to avoid all this inconvenience and the consequent liability to err the writer uses formulas (1) and (2) to determine the tooth increments to add to the pitch diameter in order to obtain the outside diameters.

For the pinion, $$T_1 = \frac{D}{P\sqrt{D^2 + D_1^2}} \qquad (1)$$

For the gear, $$T = \frac{D_1}{P\sqrt{D^2 + D_1^2}} \qquad (2)$$

In which

D_1 = diameter of pinion.

D = diameter of gear.

P = diametral pitch.

The calculation made in this way is much simpler than by trigonometry since it necessitates the use of no tables and consequently no interpolation; also it will be noticed that the denominator is the same for both equations.

To find the center angle ϕ we have of necessity to resort to our table to find the angle whose tangent corresponds to the ratio of the gears; that is:

$$\phi = \tan^{-1} \frac{D_1}{D} \qquad (3)$$

Similarly, we have for the inside and outside tooth angles I and O (where the whole depth of the tooth equals 2.157 divided by the diametral pitch).

$$O = \tan^{-1} \frac{2}{P \sqrt{D^2 + D_1^2}} \qquad (4)$$

$$I = \tan^{-1} \frac{2.314}{P \sqrt{D^2 + D_1^2}} \qquad (5)$$

These two values may, however, be determined without trigonometry by an approximate method, giving a result near enough for practical purposes, particularly for a set of gears with a large number of teeth, and by making a slight correction we may obtain as close, or closer, results than by (4) and (5) unless the decimal points are carried well out and values carefully interpolated. The approximation consists in assuming that the depth of the tooth, above or below the pitch line, corresponds to a circular arc with center at intersection of the axes of the gears. The fraction that this angle is of 360 degrees is taken as the fraction that the depth of the tooth, above or below the pitch line as the case may be, is of the whole circumference of this circle. Then

$$O = \frac{360}{P \pi \sqrt{D^2 + D_1^2}} = \frac{114.59}{P \sqrt{D^2 + D_1^2}} \qquad (6)$$

$$I = \frac{416.52}{P \pi \sqrt{D^2 + D_1^2}} = \frac{132.53}{P \sqrt{D^2 + D_1^2}} \qquad (7)$$

The maximum discrepancy would occur with a 12-tooth miter gear where the outside angle is 6° 43′ and figured by formula (6) is 6° 45′. As the results are always large, and increase as the angle, it is a simple matter to make the correction. The table herewith gives the amount in minutes to be deducted from the results obtained from (6) and (7), for various tooth angles.

Tooth Angles in Degrees.	Deduction in Minutes.
1°	.02′
2°	.05′
3°	.17′
4°	.40′
5°	.65′
6°	1.38′
7°	2.08′

To find the number of teeth for which to select the cutter we have:

$$\text{For the pinion,} \qquad \frac{P D_1 \sqrt{D + D_1^2}}{D} \qquad (8)$$

$$\text{For the gear,} \qquad \frac{P D \sqrt{D + D_1^2}}{D_1} \qquad (9)$$

The objection to the general expressions for these values, such as the number of teeth divided by the cosine or sine of the center angle, is that before the values can be obtained it is necessary to consult the table and interpolate, whereas, with (8) and (9) the results may be obtained directly.

When one is about to lay out a pair of bevel gears, the diameters and pitch are determined from a consideration of the space available, power to be transmitted, speed, etc. These having been obtained the above formulas enable one to obtain all of the data generally required to construct the ordinary pair of bevel gears, viz., outside diameter, backing, turning and cutting angles, and number of cutter to be used.

J. D. Adams.

Phœnix, Arizona.

A GERMAN SPIRAL GEAR CUTTER.

Editor Machinery:

In reference to the subject of spiral gears, upon which you have published several articles, it may be of some interest to your readers to state that we are building a special machine for making very accurate gears with helically-formed teeth in a very cheap and quick way. The sale of this machine is growing rapidly in this country (Germany) and people experienced in gear cutting are surprised at its simplicity and the accuracy of its working.

Our cutting tool is a spiral worm cutter and the great feature of the machine is that all spur wheels with straight or spiral teeth, and with any number of teeth, provided they are of the same diametral pitch, can be cut by means of a single cutter. The faults in the completed gear are therefore limited by the errors existing in the single cutting tool, which it is possible to make very perfect, and the work of cutting the teeth is rendered independent of the care and intelligence of the operator.

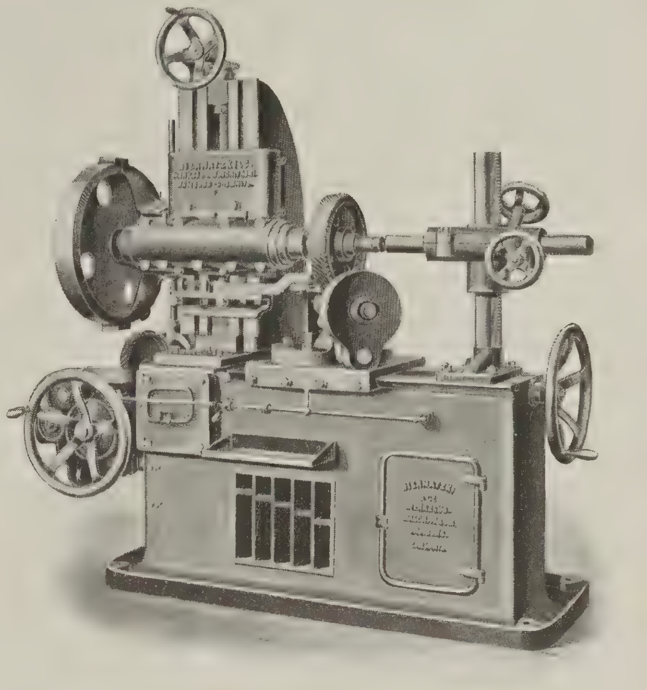
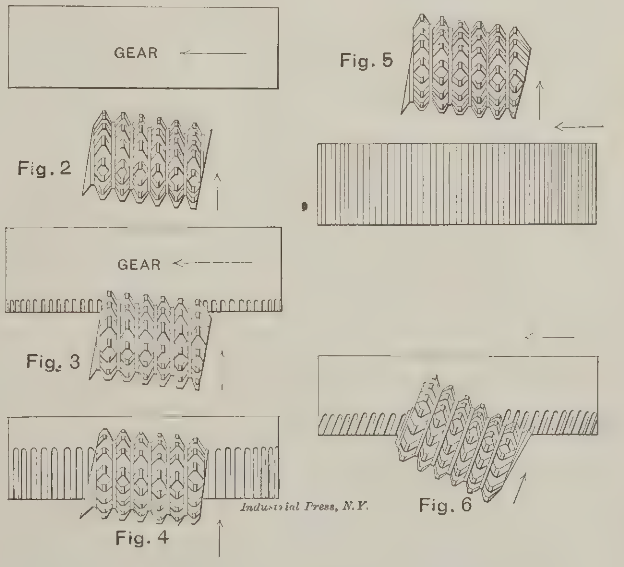


Fig. 1. Spiral Gear Cutter.

In explanation of our system, we will first describe the usual way for cutting an ordinary spur wheel with straight teeth by means of a single-thread spiral cutter. The cutter is supported on a swivel carriage and is set with its axis at an angle with the plane of the wheel to be cut, this angle being such that the plane of the gear will be normal to the spiral of the cutter. Both the cutter and blank are given a rotary motion, the cutter making as many revolutions for each rotation of the spur wheel blank as there are teeth to be cut in the latter. The cutter is now fed into the blank in a direction parallel to the axis of the latter, whereupon it begins to cut some of the teeth. As the blank rotates, all of the teeth are finally started and by degrees the cutter passes across the face of the blank and gradually cuts the teeth across the full width of its face. This action is illustrated in the diagrams, Figs. 2 to 5, inclusive, in which Fig. 2 shows the angular position of the spiral cutter before



Figs. 2-6. Illustrating the Principle of the Spiral Gear Cutter.

commencing work; Fig. 3 its position after the wheel blank has completed one revolution; Fig. 4 its position after about one-half the width of the teeth has been cut, by a corresponding number of revolutions of the wheel blank; and Fig. 5 shows the finished spur wheel, with the cutter moved beyond it.

Our method for cutting spiral wheels differs from that above mainly in that the number of revolutions of the spiral cutter, necessary for cutting a straight-toothed wheel as above described, has to be increased, say, by one revolution, while the number of revolutions of the wheel blank remains the same as before. This one additional revolution of the cutter, taken in connection with its advancing motion, gives as resultant the helical direction required for the teeth of the spiral wheel. This action is indicated at Fig. 6. It will be evident, however, that any other proportional increase of the number of revolutions can be employed such, for instance, as two, three or more additional revolutions or a fraction of a revolution, according as a greater or smaller pitch of the spiral teeth may be required. The number of revolutions of the cutter could also be reduced by one or more revolutions or fractions thereof, as above stated, instead of being increased, producing helical teeth of the opposite pitch having an opposite inclination of the axis of the spiral cutter.

In a like manner spiral wheels having an angle of spiral varying from zero to 180 degrees can be cut by one and the same spiral cutter, according as the cutter has one or more additional, or one or more less revolutions imparted to it.

These machines are patented in the United States and manufactured in our factory in Germany. The following is a summary of the advantages of the system:

1. The machine is simple in construction and easy to handle.
2. Only one cutter is required for different wheels containing different numbers of teeth, provided they are of the same pitch.
3. This greatly reduces the cost of cutters, it being only about one-half as compared with other machines with which it is necessary to use a set of 8 or 14 cutters for each pitch.
4. The form of tooth is absolutely and theoretically correct for wheels with any number of teeth and not correct by intervals only, as is the case when a set of cutters has to be used for each pitch.
5. Being formed by the same cutter, the teeth of all wheels of the same pitch, though containing different numbers of teeth, are of equal thickness at corresponding heights, consequently gears cut by this machine work smoothly and without backlash.
6. No previous nicking or preparation of the solid blank on a dividing machine is required, the machine doing its own dividing automatically during the process of cutting.
7. As several teeth of the cutter are working at once, the capacity as compared with the ordinary spur wheel cutter is much greater.

Biernatzki & Co.
Hamburg, Germany.

[This type of gear cutter is not unknown in this country, but, for some reason, no manufacturer here has made one operating on this principle a commercial success. We do not know why this is the case, for we learn from other sources, as well as from the above communication, that machines of this type are thought well of abroad and will do very rapid work. One possible reason for its non-development here is that there must necessarily be more or less elasticity in the train of gearing connecting the cutter and wheel being cut, and this may have been believed fatal to the proper performance of the work. Stiff and rigid construction, however, have evidently overcome this defect.

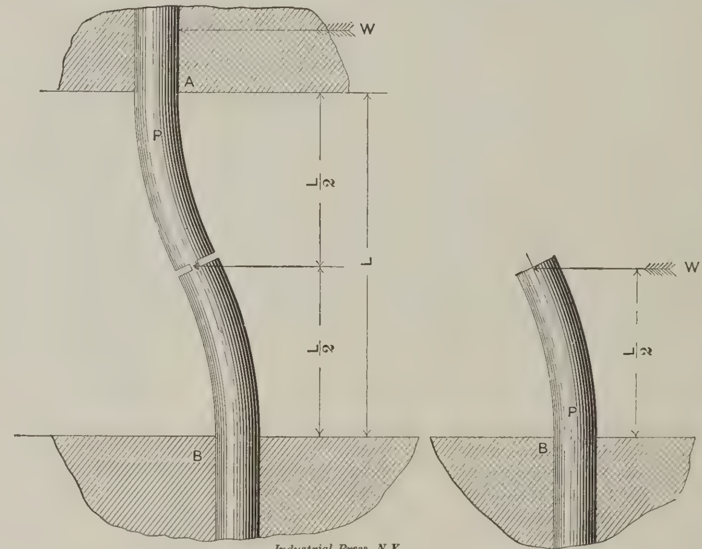
It will be observed that a gear cutter on this principle is but an extension of the principle of the worm-wheel hobbing machine manufactured by several firms in this country. What was probably the first of these machines was invented by Sir Joseph Whitworth in 1835, and since then many other patents have been issued, here and abroad, both on machines for hobbing worm-wheels and for cutting spur and spiral gears with spiral cutters. In 1889 Geo. B. Grant took out a patent on what he called a "Conjugator," a machine operating on substantially the same principle as the machine described above, though of not so good mechanical construction. Following upon Mr. Grant's invention William Sellers & Co., Philadelphia, did some experimental work in this direction, but for some reason did not see fit to develop the machine sufficiently to put it on the market. If it should happen that this letter of Biernatzki & Co. should bring out any further information upon this method of gear cutting, we should be glad to lay the facts before our readers.—Editor.]

* * *

THE STRENGTH OF FIXED BEND COLUMNS UNDER LATERAL THRUST.

Editor Machinery:

Every once in a while a person comes across something in engineering which he must think out for himself, as one is unable to find any information in the text books on the subject. One of these cases is shown in Fig. 1. The column, *P*, has one end fixed in a permanent structure, *B*, while the other end of the bar is also fixed in another structure, *A*. The latter has a lateral thrust, *W*, acting upon it. As the diameter of *P* was to be kept as small as possible, it became necessary to know what bending moment was exerted by the thrust *W*.



Industrial Press, N.Y.

Fig. 1 Fig. 2

Illustrating Strength of Columns under Lateral Thrust.

When the force was acting upon the beam, it would assume a reverse curve, as shown in Fig. 1, *A* being so arranged that it had to move parallel to *B*. The inflection point of the curve would be midway between *A* and *B*, and as the curve changes at this point, from plus to minus, the outer fibers of the beam would neither be in tension nor compression, and, therefore, if we should saw out the metal on each side, as shown, and suppose that a single fiber was strong enough to take care of the shear at this point, we would not have altered the curve or bending moment.

If the thrust *W* were now transferred to the center, and the remaining fiber removed, as shown in Fig. 2, the bending moment of the support would be unaltered. This bending moment is seen to be $\frac{WL}{2}$ which is ½ that of a simple beam of the length, *L*, with a load on the end. This beam, therefore, need only be made one-half as strong as a beam which would not be fixed at *A*. The maximum bending moment would be at the fixed ends and would be $\frac{WL}{2}$.

Frank B. Kleinhans.

PATTERNS AND PATTERN ROOM.

Editor Machinery:

Since patterns form a valuable asset in any business they should have the best of care and a careful and complete record should be kept of them. Many concerns who own patterns recognize this fact and have a system that is in keeping with the valuable and important part which these patterns have in the conduct of business. There is no reason why costly patterns should be in general disorder most of the time and usually covered with dust and dirt. There is no reason why they cannot be kept as clean as the books in the office or papers on the desk, and there is every reason for keeping them in the best of order and condition.

A little daily care and attention to the pattern room will be well repaid by the improved condition of the patterns and the general appearance of the room. There are times when one desires to show business friends around the plant, and how much satisfaction there is in a well-kept, clean and light pattern room. It is, indeed, strange how some men of good business acumen will look at the condition of some parts of their plant without a pang, and it is especially strange that they should take so little interest in the care and condition of patterns which have taken much valuable time to produce.

When a pattern is needed it is often needed in a hurry, and some scheme should be devised to locate it quickly and with facility. It is decidedly unpleasant, and irritating in the last degree, to experience trouble in locating a pattern when there is a rush order for castings from it, and no accurate record to show where it is or who had it last. The value of systems is brought out over and over again in the daily operation of the pattern shop and in no place can a system be utilized to greater advantage. Many shops have systems for keeping run of their patterns that are as good, or perhaps better, than the one that is here described, but to those that have no system the following outline may prove of benefit.

The pattern room should be in charge of one man, and he alone should have the entire oversight and be responsible for the condition of the room and patterns, and of the records connected therewith. It is always a good policy to concentrate responsibility as much as possible and, when it is practical to do so, to place one man in charge of certain departments of work, making him directly responsible for the conduct and general condition of that department. Of course there is the human element of fallibility, but the danger of mistakes can be reduced to a minimum by this one-man responsibility, leaving no opportunity for shifting the burden on others. A man having charge of the pattern room must of necessity know something about the business and about patterns in general. In some shops it is practical to turn the room over to the pattern maker and make him responsible for its condition, records, etc. This, however, cannot be done in large shops where the entire time of the pattern makers must be employed in the making of patterns, and so a man should be selected who can devote as much of his time as may be necessary to the care of this room.

It is, of course, difficult to determine just how much room should be set aside for the storage of patterns, but it should be borne in mind that conservatism in this matter is not economy, nor is it good judgment. If there is any branch of the business that increases rapidly it is the pattern department, and this fact should be taken into consideration when making plans for the pattern room. It is a still more difficult problem to arrange the shelving for the patterns, but the common shelf has proved the most satisfactory in the long run, and to this end a set of shelves should be arranged around the room on all four sides. These may be from two to three feet deep, and a trolley ladder should be employed to reach the top shelves quickly and easily. The center of the room may be utilized for the erection of another set of shelves which will be open at both sides. Very large patterns that will not go on the shelves may be arranged around the room on the floor. As the shelves are erected they should be divided off into compartments of about two feet each, so that when all of the space in a compartment has been utilized a small board tag may be suspended from the top shelf showing just what numbers are in that compartment. This will greatly facilitate the location of the patterns. When the patterns are placed in the room, insist that they be dusted every day and the room swept and cleaned as thoroughly as an office. In this way it will not be hard work to keep rooms and patterns in first-class order.

There are many different ways of designating patterns, but, in the opinion of the writer, the simple method of numbering them consecutively as they are made is the best and the least liable to confusion. In the matter of record the versatile card index is called into play. Give each pattern a card rather larger than the standard size, say 6 inches by 5 inches, and on this put the number and name of the part or piece for which the pattern is made. It will also be found desirable to keep on the record the date when the pattern was made, the cost in detail, and the weight in iron, steel, or whatever metal is used for the casting. On the reverse side a record should be kept showing the movement of the pattern, whether at home or away, and it should be impressed with special emphasis that this record must be complete and accurate. This will prevent many of the disputes and disagreements that often occur owing to inaccurate records of the whereabouts of patterns, and much trouble and delay will be avoided if the record is kept as it should be.

This system can be used by foundries doing a jobbing business by a little change in the matter of record shown on the card. In this case the record should show to whom the pattern belongs, when received, weight in metal, cost of casting and the number and name of the pattern. W. G. STEBBINS.

New London, Conn.

* * *

PEAT AS FUEL.

Since the coal famine of a year ago various sources of fuel other than the coal fields and forests of the country have been proposed—among them the peat bogs, found in many localities. The mud from these bogs consists partially of carbonized vegetable matter, caused by the decomposition of water plants, moss, grass, etc., intermingled with fibrous roots, and when dried out makes an efficient fuel. Another kind of peat, which may be designated as turf peat, consists of the mud which is found under the turf that grows in marshy places, the carbonized vegetable matter in this case consisting of decayed grasses or turf.

While it is generally known that peat will serve as a fuel, and that it is so used in some countries very extensively, it is only recently that authentic information as to its calorific power and characteristics appears to have been available. A bulletin of the Insurance Engineering Experiment Station, Boston, Mass., is devoted to the subject of "mud-fuel, coke and gas," showing that peat may be considered an emergency fuel, if nothing more.

The report refers to the Ziegler process—a German invention—for converting peat into coke and gaseous products, showing very low cost of production, based on the German scale of wages, which would have to be offset in this country by improved mechanical processes, should the manufacture of coke and by-products from peat be undertaken on a commercial scale. The report also contains the results of tests by Prof. Norton of the Massachusetts Institute of Technology, Boston, showing that the calorific power of air-dried peat, when "bone-dry," is from 9,600 to 14,000 B. T. U. per pound, or about 65 per cent. that of the best American coal. Prof. Norton makes comments on the use of peat and draws several interesting deductions. Samples of peat when wet weigh 100 to 125 pounds per cubic foot, and after drying in the air the weight reduces to about 55 pounds, when the mud becomes hard and tough, difficult to saw but easy to split with an axe. In the process of coking the tendency is for the mud to crumble; but if it is first dried thoroughly it produces a firm, dense coke, very much like the coke from soft coal. With 43,560 feet to the acre and depth, say, of 20 feet, there would be 860,000 cubic feet of mud per acre, which would yield 20,000 tons of air-dried mud, equal in heating power to 12,000 tons of good coal. If convenience in handling and diminished bulk should justify the coking process, 10,000 tons of good coke would be produced, and as there is almost, if not quite, enough gas distilled from the coke to make one pound of mud furnish the gas to coke the next, the process once started would require no extra fuel.

The success or failure of peat as a fuel here in America would seem to rest entirely upon the cost of excavating and drying it, compared with the cost of mining coal, taking into account the interest charges on the equipment. As long as anthracite coal is to be had, even at a high price, it will be preferred, because of its cleanliness, and high heating power; but in the case of fuel emergency here in the East, where people in general are accustomed to soft coal, it would seem as though peat might serve as a very efficient emergency fuel.

THE CARD INDEX IN THE DRAFTING ROOM.

REGARDING ITS USE BY THE DRAFTSMAN FOR HIS INDIVIDUAL RECORDS.

During the past few years the use of books for the keeping of records has been giving place to the more modern method of record keeping—the card index system. Introduced first in mercantile business, its use has extended, until now it is found in almost every branch of work in which the keeping of any kind of records is involved. In the up-to-date drafting room the card index found early acceptance for keeping records of drawings and similar purposes. There is, however, a place in the drafting room for the card index where it has yet to be more generally adopted, and that is as an individual adjunct to each draftsman's outfit. Years ago Nystrom said: "Every engineer should make his own pocketbook, as he proceeds in study and practice, to suit his particular business," and there is no better way of compiling a pocketbook than by the use of the card index. Outfits for this purpose may be purchased in all styles and prices, from the trial outfit of 3 x 5 cards, in a pasteboard case and costing about 75 cents, up to the most elaborate cases and trays for the 5 x 8 cards. As the individual index is of value primarily only to the draftsman using it, it may be difficult to persuade the "Company" to provide such outfits, so that as a beginning it may be necessary for the draftsman who is desirous of starting his own collection of data to provide himself with an outfit composed of materials that can usually be found at hand.

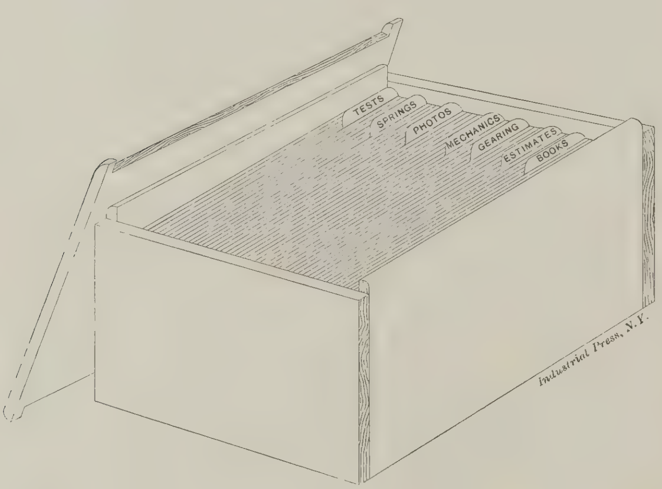
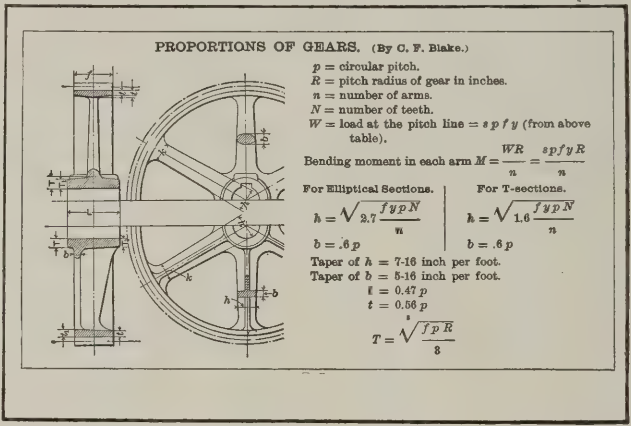


Fig. 1. A "Shop-made" Card Index Box.

Fig. 1 is a sketch of a very cheap and serviceable index box that can be readily put together in the pattern shop and is in some ways better suited to this particular purpose than those purchased of the regular dealers in such goods. Being made of ½-inch pine, planed down to about ⅜ inch, it is very light and much more easily handled than the regular cases, which are usually made of oak. Another point in its favor is that it can be made much shorter than any of the regular trays which come in lengths of from 12 to 14 inches, and are, therefore, of a size that would prove unhandy upon a draftsman's board. A package containing 100 index cards of medium weight measures a little less than an inch in thickness, so that a box 4 or 5 inches deep will hold a sufficient number of cards to cover a long period of the average draftsman's experience. The object should be to compress the entire outfit into a size and weight which shall not greatly exceed that of an ordinary reference book.

Cards for these outfits are provided mainly in 3 x 5, 4 x 6, and 5 x 8 inch sizes, but if the index is to be put to all of the uses which are mentioned later, the cards should not be less than the 4 x 6-inch size. Either of the two larger sizes, if used in a short, light tray, will be found fully as convenient to handle as the ordinary tray for the smaller cards when it is of the usual length and constructed of oak. The cards chosen should be of sufficient size to allow of fairly lengthy computations, and for mounting complete tables and similar data clipped from periodicals. If home-made cards are to be used they can be easily cut from Manila or stiff white drawing paper, and will answer the purpose very satisfactorily. Guide cards are cut from the same material and labeled to suit the matter to be indexed. In the case illustrated no provision whatever is made for locking the cards in as none is considered necessary. When it is desired to refer constantly to a certain card or cards they may be easily slipped out and placed on the drawing board for the time being and any device which makes it necessary to lock and unlock in order to do this, or to remove and add cards, will, after a short trial, be found to be more of an objection than an advantage.

The uses to which the index can be put will suggest themselves to each draftsman as the requirements of his work present them. In the first place there are certain tables to which every draftsman has constantly to refer, and these should form a foundation of the index system. Such data as decimal equivalents, squares and cubes, trigonometrical functions, etc., furnish the most natural beginning. These are to be found in the handbooks in common use, such as Kent and Nystrom, but when only one table is needed for a particular use the convenience of drawing out a single card over the necessity of handling the whole book, will at once be apparent. Often several tables are used at the same time, and then the pages of the book must be turned back and forth, or, perhaps, two or more books must be referred to. With the index system any number of cards may be placed side by side where the draftsman may refer to them without trouble. Having started with the tables most commonly used the index will grow with considerable rapidity. If any unfamiliar table or data is to be consulted, much time may be lost in searching for it through the different handbooks, but if, when found, it is copied on to an index card, it is then ready for immediate use if again needed. Clippings from periodicals have before been referred to, and the value of a year's subscription to any good technical publication will be wonderfully increased if all of the data that is published pertaining to one's particular line of work is placed upon the cards. Fig. 2 is an illustration of a data card upon which is mounted one of the tables taken from a MACHINERY data sheet.



PROPORTIONS OF GEARS. (By C. F. Blake.)

p = circular pitch.
R = pitch radius of gear in inches.
n = number of arms.
N = number of teeth.
W = load at the pitch line = $s\,p\,f\,y$ (from above table).

Bending moment in each arm $M = \frac{WR}{n} = \frac{spfyR}{n}$

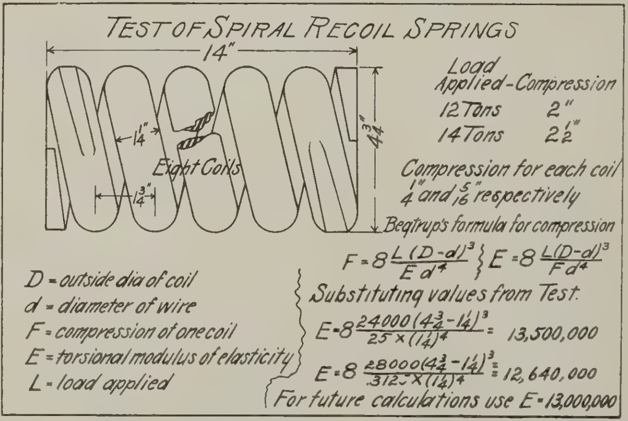
For Elliptical Sections.	For T-sections.
$h = \sqrt{2.7\frac{fypN}{n}}$	$h = \sqrt{1.6\frac{fypN}{n}}$
$b = .6p$	$b = .6p$

Taper of h = 7-16 inch per foot.
Taper of b = 5-16 inch per foot.
$l = 0.47\,p$
$t = 0.56\,p$

$$T = \sqrt[3]{\frac{fpR}{8}}$$

INDUSTRIAL PRESS, NY

Fig. 2. The Card Index used for Clippings.



TEST OF SPIRAL RECOIL SPRINGS

14"
1¼"
1¾"
4¾"
Eight Coils

Load Applied	Compression
12 Tons	2"
14 Tons	2½"

Compression for each coil ¼" and 5/16" respectively

Beqtrup's formula for compression

$$F = 8\frac{L(D-d)^3}{Ed^4} \quad E = 8\frac{L(D-d)^3}{Fd^4}$$

D = outside dia of coil
d = diameter of wire
F = compression of one coil
E = torsional modulus of elasticity
L = load applied

Substituting values from Test.

$$E = 8\frac{24000(4\frac{3}{4}-1\frac{1}{4})^3}{.25\times(1\frac{1}{4})^4} = 13,500,000$$

$$E = 8\frac{28000(4\frac{3}{4}-1\frac{1}{4})^3}{.3125\times(1\frac{1}{4})^4} = 12,640,000$$

For future calculations use E = 13,000,000

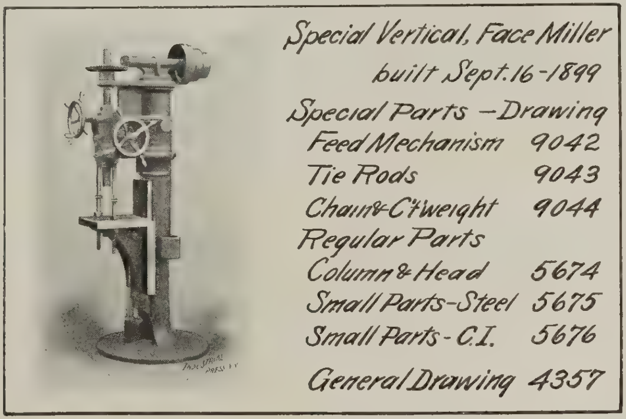
INDUSTRIAL PRESS, NY

Fig. 3. The Card Index used for Record of Tests.

Reviews of all technical books that the owner reads should find a place upon these cards. To thoroughly digest any book there is no better plan than to make notes and extracts as the reader proceeds, and if these are afterward placed in his index, they will often prove of the greatest value.

In many drawing rooms the draftsman is provided with a note book in which to record all calculations, estimates, and other computations that may arise in connection with his work. After one of these books has been in use for several months, and a mass of calculations has accumulated therein, it is a most tedious job to search them over for the figures applying to the matter in hand. If, however, the calculations are made upon index cards and filed under appropriate headings, they may be found at a minute's notice.

A draftsman is often called upon to design certain pieces of mechanism in which the strength of the material must be taken from general data and may vary considerably from the strength of the material actually used. In such a case it may be practical to make subsequent tests and from these to obtain definite data. The card shown in Fig. 3 is taken from the writer's index and serves to illustrate the way in which the results of such tests can be recorded. The problem in this case was to design a spring that should stand a load of about 25,000 pounds and to determine its deflection when loaded. The spring was designed and the compression figured by Begtrup's formulas, in which the modulus of elasticity is given as from 10,000,000 to 14,000,000, and the exact modulus to be used is left to the judgment of the designer. After these springs were made they were tested, with the results shown on the card, and substituting the actual deflection for given loads we are able to determine a modulus of elasticity, in this case about 13,000,000, which can be regarded as comparatively exact data for use in designing springs that are to be made of the same material and to perform similar duty. If similar comparisons be made of castings and forgings of various kinds we soon accumulate a quantity of very reliable information that applies more closely to our particular cases than any published data which must, at best, be only general in its nature.



Special Vertical, Face Miller
built Sept. 16-1899

Special Parts – Drawing

Feed Mechanism	9042
Tie Rods	9043
Chain & C'tweight	9044

Regular Parts

Column & Head	5674
Small Parts-Steel	5675
Small Parts - C.I.	5676
General Drawing	4357

INDUSTRIAL PRESS, NY

Fig. 4. The Card Index used for Record of Special Machines.

Photographs of machines built, and data connected with them, will prove valuable additions to the index. Fig. 4 shows a record of special vertical milling machine, and explains just which parts were special and which regular, and provides a complete record of the drawings used and any information that would be of aid to the draftsman if called upon to design a similar machine at some future time.

* * *

ITEMS OF MECHANICAL INTEREST.

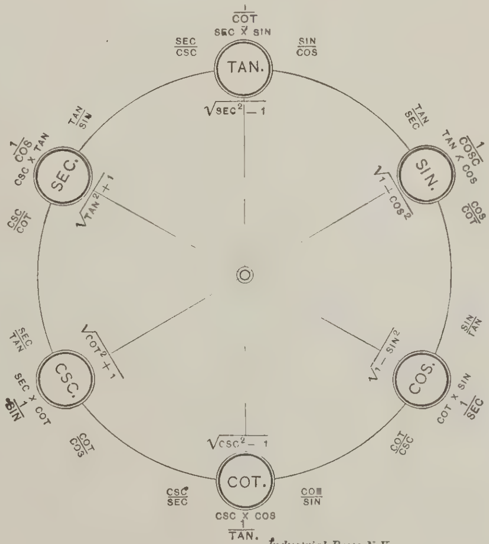
RELATION OF TRIGONOMETRICAL FUNCTIONS—SURFACE PLATE FOR LONG LEVERS—THE INVENTION OF BABBITT METAL—THE PRODUCTION AND USE OF CARBORUNDUM.

From investigations made in Germany it appears that wood which has been floated in rafts, or has in any way been for a long time immersed in flowing water, is better fitted for reliable joinery and building purposes. The water dissolves the sap, albuminous and salty substances in the pores and makes the wood less hygroscopic, that is, less likely to absorb dampness. Kiln-dried lumber containing large quantities of sap, may shrink, split or warp under certain conditions, but the liability of doing so is much lessened in the case of floated timber. The same condition can be obtained artificially. In a German process for drying wood described by Consul-General Hugue of Coburg, Germany, the boards or planks are piled up in a long iron box, with narrow spaces between; the lid is then tightly screwed down, so that neither water nor steam can escape. Steam is then turned into the box at a continuous pressure (3 to 5 pounds per square inch), and this process is continued for from sixty to seventy-two hours, the exact length of time being determined by the hardness and density of the wood. The steam opens up the wood and kills the protoplasm which is still alive in the cells. After having been thus prepared, the wood goes into a water bath, where it is kept for about a fortnight. The drying process then follows.

To shoot, yet not to shoot, is the problem solved by a Swedish inventor, for the protection of those in the vicinity of young army greenhorns who are learning to become marksmen, as well as to save ammunition now wasted in practice. The apparatus comprises a dummy gun mounted on a universally mounted support so that the gun may be pointed in any direction. A pointer, whose position is controlled by the position of the gun, indicates the slightest movements of the latter, and at the moment the trigger is pulled the pointer is automatically locked in the position at which it was at that instant. Graduations near the pointer show the direction the gun was pointing when the shot was supposed to have been fired and register the deviation from the bullseye that would have occurred had a real rifle been aimed at the same angle as the dummy gun fired by the pull of the trigger.

THE RELATION OF TRIGONOMETRICAL FUNCTIONS.

Prof. W. H. Wilson has prepared a diagram that illustrates in a very concise manner the symmetry of the relations of the trigonometrical functions. A careful study of this diagram, which is here reproduced, will prove of great aid in memorizing the relations which these functions bear to one another. Referring to the cut it will be seen that:



Industrial Press. N. Y.

Fig. 1. Showing Relation of Trigonometrical Functions.

Each function is the reciprocal of its diametrical opposite.

Each function is equal to the ratio of the first and the second in either direction.

Each function is equal to the product of its two adjacents.

Each function is equal to an expression involving the square of an adjacent, a radial and unity.

DIE WORK ON A LARGE SCALE.

In this country some of the heaviest die work has been the rather unpleasant but exceedingly interesting process of manufacturing coffins of metal sheets by means of a heavy press and dies. *Page's Magazine*, London, however, describes the process of the Heslop Seamless Steel Boat Works, an English concern, which affords an illustration of die forging or pressing on an immense scale. It is not found practicable to press a boat from one sheet of steel, due to the puckering of the sheet, so all boats are pressed in halves, and afterward jointed along the keel. There is an advantage, however, in this, namely, that it permits of the insertion of a stiff keel of I section, bent to the required curves, to which the thin flanged edges of the halves are riveted. With the exception of this, all the boat fittings are of timber. The advantage of the steel hull is that it does not shrink as timber does, in hot climates, and that a blow will only bruise, without fracture occurring. The firm turns out some three hundred boats a year. The dies used are so massive that they are built up and bolted together in sections. The cost of the entire stock of dies for boats of different sizes up to 35 feet and 40 feet in length, must have been enormous. The dies are arranged in line with the heating furnace, out of which the sheet to be pressed (of ⅛ inch steel) is drawn. It is located in place on one edge of the lower die by means of cotters driven by men stationed in a row. The lower die is then lifted hydraulically, and the sheet pressed to shape at once.

SURFACE PLATE WITH V-GROOVE FOR LAYING OUT WORK.

In the construction of the linotype machine a number of long light levers have to be mounted on comparatively slender shafts at right angles to same and certain holes have to be located in the levers in accurate relation to one another. In the shop of the Ott. Mergenthaler Co., Baltimore, Md.—who were the original builders of the linotype machine—a surface plate was used for this work and is still used for similar work. In fact the scheme is one that can be profitably employed in many shops as a time-saver and promoter of accurate work. In the plate a V-groove is planed across one end exactly at right angles to the side *A*. Holes are tapped along the side of the groove for clamps. A shaft with its lever is shown in position for laying out holes in the lever. The shaft *D* is clamped in the V-groove so that the arm *B* stands along the side *A*. With calipers the right angularity can be tested. Holes can be laid out in any desired relation by means of a surface gage, etc.

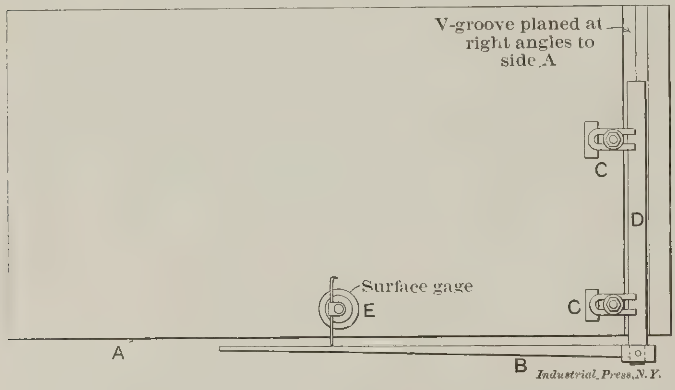


Fig. 2. Surface Plate for Laying Out Long Levers.

REGARDING THE INVENTION OF BABBITT METAL.

Although "babbitt" metal is one of the most common antifriction metals in use at the present time, but few users of this metal are aware that Isaac Babbitt, whose name it bears, was the inventor and patentee of the method of lining boxes with soft metal rather than of any particular alloy of the metal itself. The *Metal Industry* recently published a copy of the original patent, No. 1,252, which was granted to Isaac Babbitt, of Boston, Mass., July 17, 1839. In this he claims to have invented a new and improved mode of making boxes in which gudgeons or journals are to run. To quote from that part of his patent relating to the metal used, he says: "I prepare boxes which are to be received into housings or plummer blocks in the ordinary way of forming such boxes; making them of any kind of metal or metallic compound which has sufficient strength and which is capable of being lined. The inner parts of these boxes are to be lined with any of the harder kinds of composition known under the names of britannia metal or pewter, of which block tin is the basis. An excellent compound for this I have prepared by taking 50 parts of tin, 5 of antimony, and 1 of copper. But I do not intend to confine myself to this particular composition."

No claim whatever is made for the composition and, in fact, that specified is somewhat softer than what is now known as "Genuine Babbitt," which is commonly composed of 96 parts of tin, 8 parts antimony, and 4 parts copper.

Although Babbitt's name is somewhat erroneously applied to the metal yet, as he was the first to exploit the use of soft metals in the manner in which they are now so commonly employed, it seems but just that his memory should be perpetuated in this way. After devoting some time to the production of metals he engaged in the manufacture of soap and his name is now as well known in the household as in the shop.

CUTTING LEFT-HAND THREAD WITH RIGHT-HAND TOOLS.

A correspondent of the *American Electrician* shows a slight variation of the old scheme of cutting a left-hand thread on a rod by means of a right-hand tap, inasmuch as he shows how to do it with a die-stock, whereas the ordinary plan is to use a vise in combination with a tap and a V-block. The accompanying sketch shows the arrangement. The dies are opened sufficiently to admit a right-hand tap of the desired lead, and the rod to be threaded. The rod is backed up by a piece of annealed copper into which the threads may imbed themselves without injury. The die should be of the same lead as the tap, which permits the tap being accurately meshed with its thread. With this combination it is claimed that a fair left-hand thread may be cut with the ordinary right-hand equipment. It now remains for some ingenious reader to show us how a left-hand nut can be cut with extemporized tools.

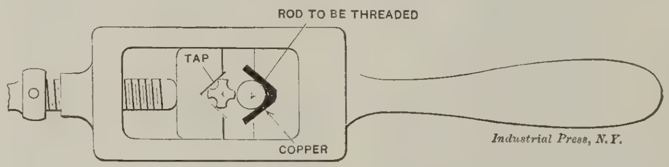


Fig. 3. Cutting Left-hand Thread with Right-hand Tap.

WHY ALUMINUM IS NOT EASILY SOLDERED OR PLATED.

The ever-present, invisible film on an aluminum surface, has a great influence on the success of various operations, especially soldering. The film is supposed to have considerable strength and continuity, and if it is broken or removed by mechanical means the aluminum immediately forms a new one. In soldering aluminum the principal difficulty seems to be due to the failure of the alloy used as a solder to adhere to the aluminum, a condition attributable to the protective film, which must be eliminated before the metals can unite. A successful solder consists of about 21 per cent. of zinc, 76 per cent. of tin and 3 per cent. of aluminum; it may be applied directly to a cleaned aluminum surface without the use of a flux, and at a temperature but little above that which is necessary for soldering copper or iron. There are certain advantages in the apparent complication which the use of a flux involves; a suitable solvent for the oxide film increases the rapidity of the soldering process, increases the certainty of adhesion and enables cheaper soldering mixtures to be used. The requirement for such a flux is that it should dissolve the coating and leave a clean surface for the solder to unite with, upon application of heat; it seems that water cannot be a component of a suitable flux. A material which, for certain solders, forms an admirable flux, is stearic acid; by applying it to a freshly scraped aluminum surface and then applying a tin-lead-zinc alloy, the matter of soldering aluminum presents scarcely greater difficulties than does the soldering of other metals. This almost ever-present coating upon aluminum is also the source of difficulty in the deposition of a permanent coating of other metals upon aluminum surfaces; while it is very easy to deposit a layer of metal upon aluminum from almost any plating solution, in the great majority of operations the resulting coating can readily be removed, sometimes in remarkably thin and continuous layers. The prime requisite in successful depositions on aluminum is the complete removal of the protection film, so that the electro-deposited metal may be applied over the complete surface of and in intimate contact with the aluminum; if this condition is fulfilled, and the coating is non-porous, it will be durable. The converse of this operation, *i. e.*, the electro-deposition of aluminum upon other metals, appears to be impossible from aqueous solution.—*Electrochemical Industries.*

AN EQUATING MICROMETER.

A very ingenious micrometer and recording gage, of English design, is illustrated in Fig. 4. The micrometer portion of this instrument follows the usual lines of construction except that the barrel, which is usually knurled, is in this case formed into a multiple threaded worm which operates a disk mounted below and carrying a series of figures representing various equivalents of the measurement made by the jaws of the micrometer. A bracket is fastened to the bow of the micrometer for carrying this worm disk and there is also a fixed disk which stands in front of the revolving one and has a series of holes through which the numbers on the revolving disk become visible as the worm is rotated.

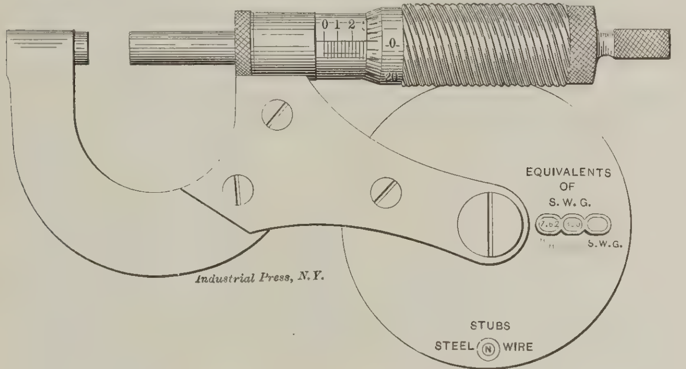


Fig. 4. English Equating Micrometer.

As shown in the cut, the jaws of the micrometer are set at .3 inch and on the dial may be read its metric equivalent 7.62 mm; also 300, denoting the number of thousandths; and 1, over S. W. G. indicating that .3 is the equivalent of No. 1 Stubs wire gage. At the bottom of the disk is another dial for Stubs steel wire in which the size *N* is indicated. This, however, is slightly misleading, as the letter will not occupy the exact center of the opening until the jaws of the micrometer have been moved .002 inch more, giving an opening of .302. A line on the worm disk corresponding with a similar line on the beveled edge of the hole in the outer disk indicates when the exact opening is reached. It is, of course, perfectly practical to apply this arrangement to any kinds of measurements for which the micrometer may be used, and in place of the equivalents here indicated we might have fractions of an inch, sheet metal gages, screw sizes or any other equivalents that might be desired by the user. This instrument is manufactured by Grimshaw & Baxter, London, England.

THE PRODUCTION AND USE OF CARBORUNDUM.

From the new catalogue just issued by the Carborundum Company, Niagara Falls, N. Y., we extract the following interesting information in regard to the production and use of carborundum, which they are producing in large quantities by the aid of electric power furnished by the Niagara Falls Power Co.

The crude materials which are used in the production of carborundum are sand, coke, sawdust and salt, and the first step taken is to reduce the coke to kernels of suitable size to be used as core, and ground to a fine powder to be used in making the mixture or charge for the furnace. To effect this the coke is first passed through a grinder which breaks it up into small pieces. It is then conveyed to the top of the building where it is passed successively through two cylindrical screens, the first of which removes all particles of coke which are too small to form the core, while the second allows kernels of requisite size to pass through its meshes and fall into a core bin, conveniently situated as regards the other constituents of the mixture. Below this bin are scales on which the sand, coke, sawdust and salt are weighed out in proper portions and then conveyed by an elevator to the mechanical mixer, from which the mixture, ready for use, is emptied into a bin.

In the furnace room are fifteen furnaces, built of brick in the form of oblong boxes, the internal dimensions of which are 16 feet in length, 5 feet in depth and 5 feet in width. In the center of the ends are the electric terminals consisting of carbon rods. The side walls of the furnace are first built up to a height of about four feet. The mixture is then thrown into the furnace until it is rather more than half full. A semicircular trench is now formed, the bottom of the trench being a little above the level of the bottom row of carbons, and into this trench is introduced the core. The top is rounded off neatly by hand, so that when finished a solid cylinder 21 inches diameter by about 14 feet long is produced, composed of small pieces of coke, and extending from either end of the furnace. The walls are now built up to a height of about 5 feet and the mixture thrown in and heaped up to a height of about 8 feet.

The electric current by which the furnace is operated is received from the Niagara Falls Power Co. at a pressure of 2.200 volts and must be transformed to lower voltage before passing through the furnace. One of the largest transformers in the world is used to reduce this current to 185 volts, but it may, by means of a regulator, be raised to 250 volts or reduced to 100 volts. The current is at first raised so as to overcome the resistance of the core, which is always greatest when new, but after about an hour the resistance decreases to normal when but little regulation is required, and the volume of the current has increased to a point where 746 kilowatts is expended in heating the furnace. This is continued for a period of about 36 hours after which a few hours more are allowed for the furnace to cool. Then the side walls are taken down and the unchanged mixture raked off from the top until the outer crust of amorphous carborundum is reached. This crust is cut through with steel bars and can then be easily removed from the inner crust of amorphous carborundum. The inner crust is then removed with a spade and the crystalline carborundum exposed, radiating from the core in beautifully colored crystals to a distance of ten or twelve inches. A single furnace yields about 7,000 pounds of crystalline carborundum.

After the carborundum has been removed from the furnace it is taken to a crusher where it is passed under rolls that break the mass of crystals apart. From here it is taken to wooden tanks where it is treated for several days with dilute sulphuric acid to remove all impurities. Then it is thoroughly washed and graded. There are twenty grades of crystals, from No. 8 to No. 220, the numbers indicating the meshes to the linear inch of the screen through which the crystals have passed. The washings pass through a series of tanks which serve to collect the fine powders, and from these are made the so-called "flours" and hand-washed powders.

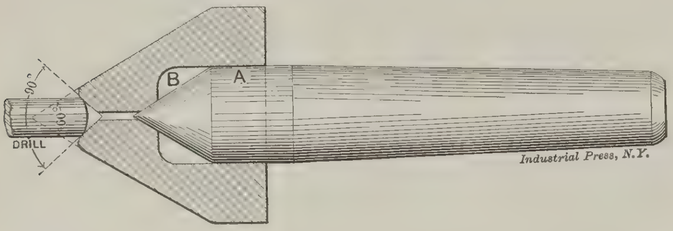
Carborundum is apparently infusible and is quite insoluble in water or any acid. Its hardness lies somewhere between nine and ten degrees, probably very close to ten degrees, which is the hardness of the diamond. Its specific gravity is 3.123, which is less than that of emery, one and one-quarter pounds of the latter being equal in volume to one pound of the former. It is used mainly for grinding wheels of all kinds and also in the shape of sticks, knife sharpeners, hones, scythe stones, cloth, paper, etc.

In the manufacture of the wheels, the carborundum is mixed in certain proportions with kaolin and feldspar, and the mixture is then placed in a mold and pressed in a hydraulic press. The wheel, when removed from the mold, is placed on a support called a "bat," which is made of baked clay. The vitrification of the wheels is carried on in kilns similar to those used in making porcelain. The "bats" upon which the wheels rest are placed on clay in "saggers" and are then built up in columns until they reach the roof of the kiln. When the kiln is filled it is closed and fired, an operation occupying about seven days, and is then allowed to cool slowly. When the wheels are removed they are placed in lathes and trued up with a dresser or diamond.

CONTRIBUTED NOTES AND SHOP KINKS.

AN IMPROVED FORM OF PIPE CENTER.

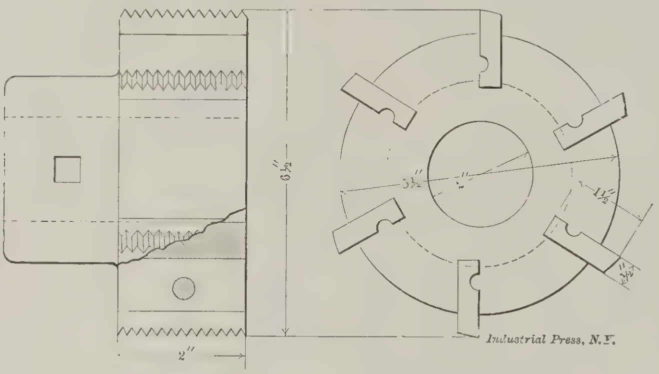
A. Putnam sends a sketch of a combination pipe and female center which, when carefully made and hardened, will be found very useful for a much wider range of work than is reached by the ordinary form of pipe center. It is turned at an angle of 60 degrees on the outside, for pipe use, while the point has a 90-degree female center for use with drills, as illustrated. It should be a good fit at *A* and is cut away at *B* so that the bearing surface and consequently the friction on the tail center is reduced. A small hole is drilled completely through the end of the center to allow the air in the space *B* to escape when the fit at *A* is very snug.



Industrial Press, N.Y.

A LARGE TAP WITH CAST-IRON BODY.

A. B. G. sends a sketch of a large tap which was made by casting tool steel blades into a cast-iron body. The blades, of which six were used, were grooved and drilled so that the iron could fasten to them more securely. They were finished all over and then passed through melted metal in order to warm them up before casting. When the castings were finished as required, they were heated all over, dipped, and the temper drawn. One of these taps served for tapping over 200 valves and it could then be annealed, recut and hardened for further use. The taps were used in a lathe on a boring bar to which they were fastened by a square key passed through the shank of the tap. A few dimensions are given on the sketch to show the size of the cutters and the general proportions of the tap.



Industrial Press, N.Y.

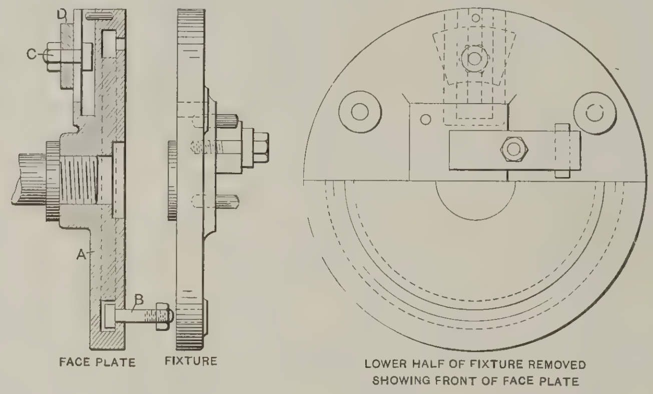
REMOVING SHAFTS FROM BABBITTED BOXES.

Regarding this subject N. G. B. writes: I have noticed in several repair shops the methods used when babbitting solid boxes and in most cases I note that trouble is experienced in removing the shaft, as it often sticks very tight. Machinists hold various opinions as to the best remedy for this trouble; some advise wrapping a piece of oiled writing paper around the shaft, others advocate the use of oil, and still others believe that the shaft should be smoked.

It happened the other day that we had several pulleys to babbitt on a 1¼-inch shaft. On one of these we tried the oiled paper and it was necessary to use a hammer to remove the shaft. On the second the shaft was simply oiled and still it stuck. The third shaft was smoked and this likewise stuck. We also had two boxes to be babbitted and on the shafts for these we used white lead. These shafts almost fell out from the box. While this "kink" may not be new to all of the readers of MACHINERY, there are doubtless many who will find the use of white lead of considerable assistance when they have work of this kind to do.

A FACEPLATE FOR USE WITH CHUCKING FIXTURES.

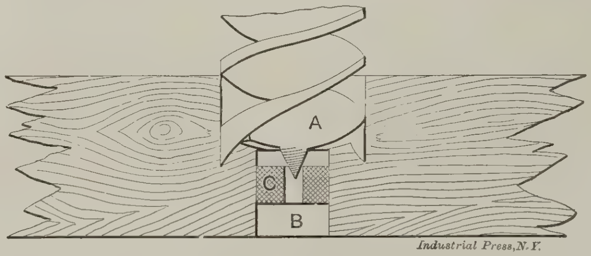
The accompanying sketch, sent us by R. E. F., illustrates a means for centering chucking fixtures accurately, and balancing them to prevent the vibration which results when large, lopsided masses of iron are revolved rapidly. The faceplate, *A*, is screwed onto the spindle in the usual manner and the fixtures are all made with a uniform base, and have three holes for the clamp bolts, *B*, and an accurately turned boss which enters a corresponding counterbore in the faceplate. On the back of the faceplate is a radial T-slot which holds the square headed bolt, *C*, and secures in place a counterweight, *D*. At the end of the slot is placed a stop-pin to guard against an accidental discharge of the counterweight by centrifugal force. The clamping bolts, *B*, are held in the faceplate by a circular slot so that the fixture may be revolved in relation to the faceplate and, with the provision shown for adjusting the counterweight, the whole rig, with work in place, may be balanced to run without perceptible vibration. Several sizes of counterweights are provided so that pieces of widely varying weights may be counterbalanced.



Industrial Press, N.Y.

COUNTERBORING HOLES FOR PATTERN WORK.

"Patternmaker" writes that the following "kink" often comes very handy to him when he finds it necessary to counterbore a hole in a pattern. Under ordinary circumstances the large hole *A* would naturally be bored first and then in the bottom of this would be drilled the smaller hole *B*. It is not, however, always practical to do the work in this order, so if the small hole *B* has been drilled first, and it is then necessary to counterbore the hole *A*, it is accomplished with the assistance of the small lead disk shown at *C*. A liberal assortment of different sizes of these disks is kept in the tool chest and even if one of the exact size is not at hand the softness of the metal readily permits one of a larger size to be shaved down with little trouble. This disk fills the small hole and affords a center for the screw of the drill which is thus led concentric with the hole first drilled. This is a much more satisfactory as well as quicker way of doing this work than the ordinary method of driving a temporary plug in the small hole.



Industrial Press, N.Y.

* * *

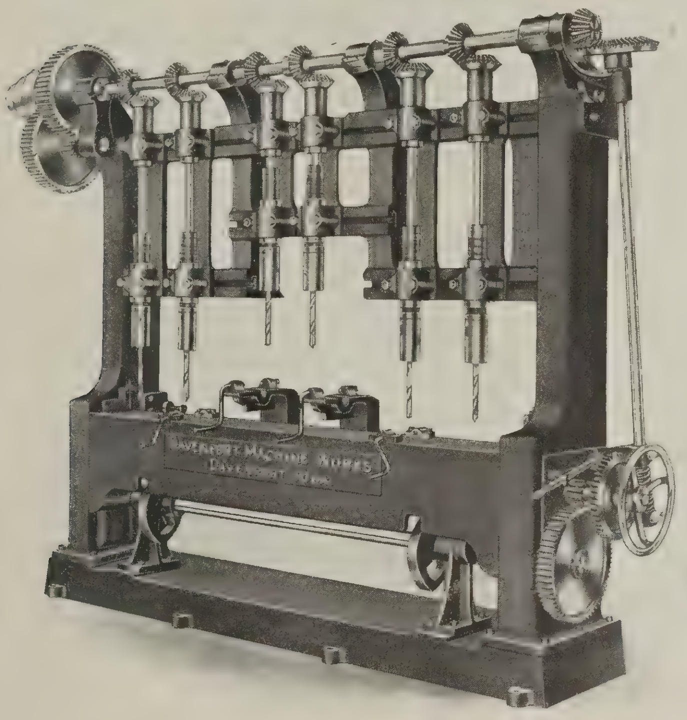
Working on the principle that if a power hack-saw having one saw is a good thing, a machine having two oppositely disposed saws will be twice as good, a British firm has brought out a power hack-saw for sawing I-beams in which two saw frames stand in a vertical position and attack the beam from opposite sides at the same time. It is said that the machine will cut through a 12 x 5 inch steel girder in 20 minutes, and that the opposite saw cuts will not deviate more than 1-32 inch at the meeting point.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

A NEW ARCH-BAR DRILL.

The Davenport Machine Works, Davenport, Iowa, have just brought out the new arch-bar drill which is illustrated in the photograph herewith. This machine, as shown, carries six spindles but it may be arranged for carrying eight if required. The crown of the arch-bar being drilled is held in a double support while the ends rest directly upon the table of the machine. The spindles have lateral adjustment for change of centers, and each spindle can be adjusted vertically to allow the use of drills of different lengths. The table, with the work, is fed up to the drills by means of two cams, one under each end of the table, which are driven by worm and spur gearing from the driving shaft. The table, which is counterbalanced, may also be raised or lowered by hand.


Davenport Arch-bar Drill.

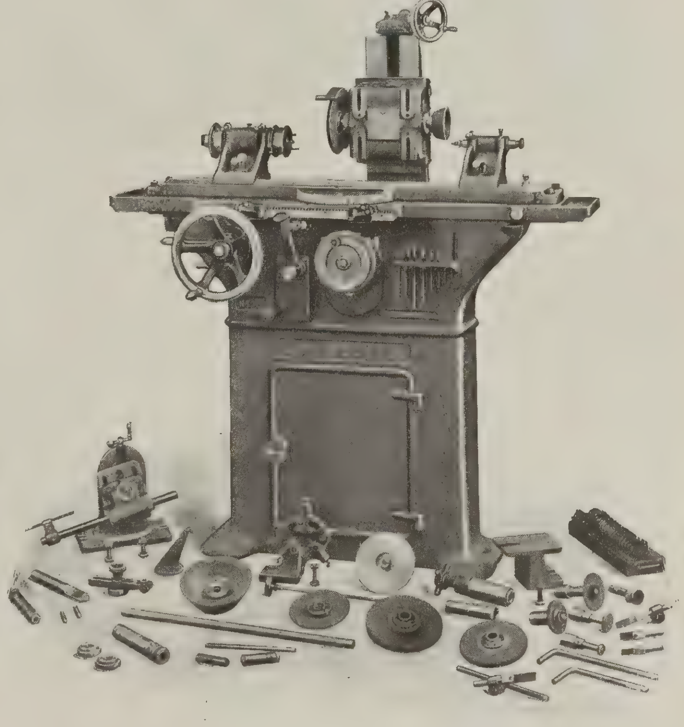
The drills are driven from a main shaft which is strongly back-geared to a three-step cone pulley carrying a four-inch belt. An automatic stop and quick return for the table also are provided. The width of the machine between housings is 7 feet and 4 inches, and it has a capacity for operating, at one time, six 1 15-16-inch drills with a feed of 1-64 inch per revolution of the drill. The weight complete with countershaft is about 12,500 pounds.

NEW UNIVERSAL AND TOOL GRINDING MACHINE.

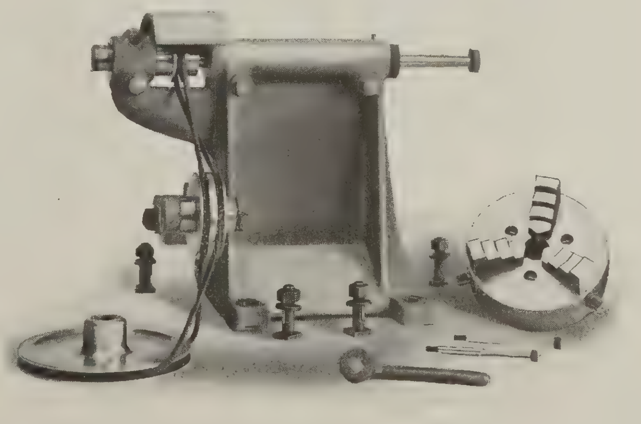
The accompanying photographs illustrate a new grinding machine that has just been placed upon the market by the Brown & Sharpe Mfg. Co., Providence, R. I. As the name implies, this machine partakes in its nature, both of the universal grinder and the tool grinder, being designed to meet the requirements of the tool room for grinding milling cutters, formed cutters, beveled cutters of any angle, straight and taper reamers, etc., and also adapted to cylindrical grinding, either straight or taper. It is especially adapted to the needs of shops where the volume of work does not warrant the installation of different grinding machines to accommodate the variety of work that can be ground upon this machine. The arrangement of the various parts of the machine has been made with a view to facility of manipulation, simplicity and ease of access.

The grinder is provided with a swivel table which turns on a central stud and can be set to 45 degrees either side of the center line. Fine movement of this table is obtained by means of a thumbscrew adjustment. The table has an automatic longitudinal feed of 17 inches which is regulated by dogs that are provided with screws for fine adjustment. There are four changes of table feed, ranging from 6.7 to 40 inches per minute. A hand wheel is also provided for hand feed of the table, coarse or fine feed being obtained by a movement of the lever which controls both hand and power feeds.

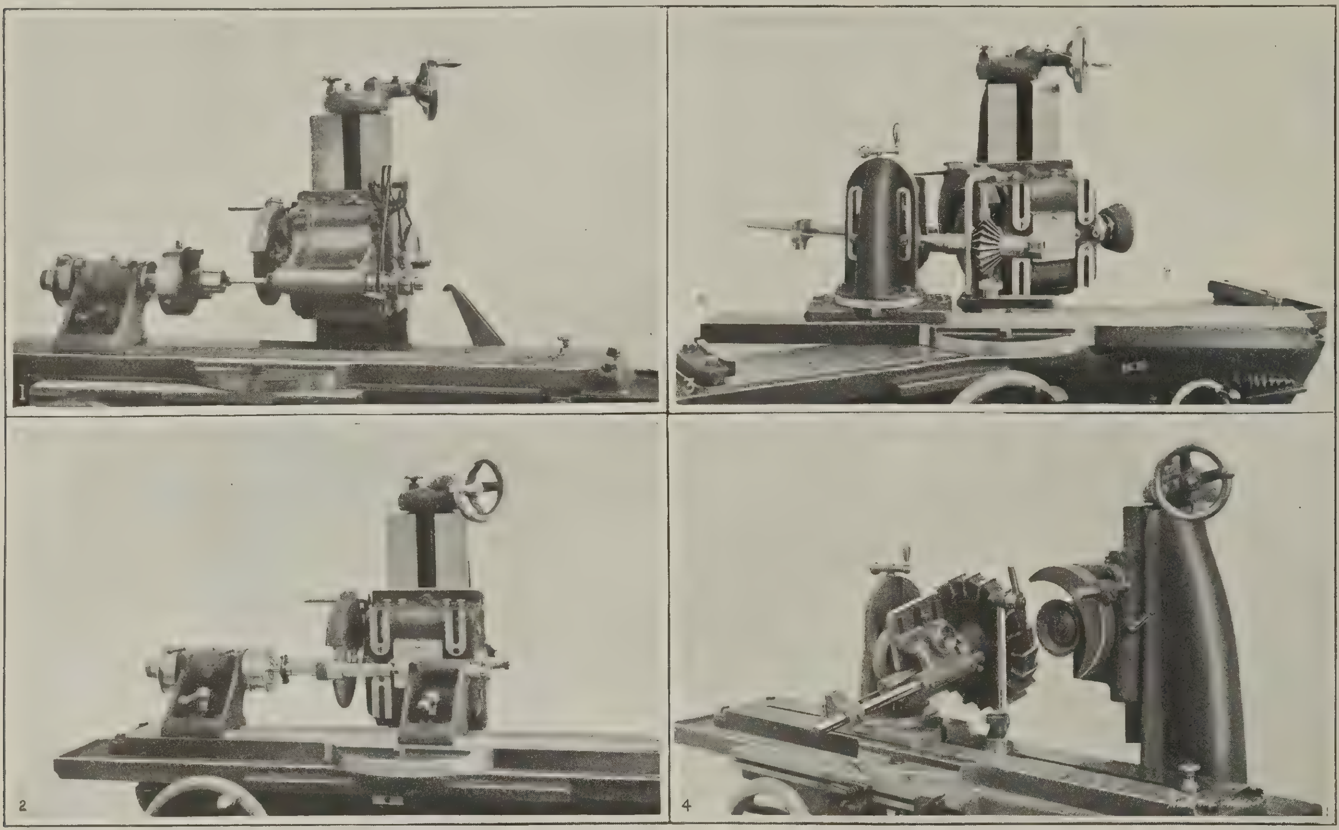
The headstock and footstock have No. 3 taper holes and permit carrying work between the centers up to 8 inches in diameter by 24½ inches in length. The head spindle has both tight and loose driving pulleys and the front end is threaded to receive a chuck or faceplate. The footstock spindle can be adjusted longitudinally and has a fine adjustment by means of thumbscrews.


Brown & Sharpe Universal and Tool Grinding Machine.

The headstock and footstock may be replaced by the universal head, shown on the floor at the left of the machine, for holding all forms of milling cutters directly by the shank or arbors, also for holding cutter bars to receive work mounted on sliding shells. The headstock sleeve and pulley can be removed and placed in the universal head, for grinding work that is larger in diameter than can be swung on the centers. The base is graduated to degrees around its circumference and the tool head swivels to 90 degrees either side of zero. The tool head has a vertical hand adjustment of 4 inches and at its extreme height will swing 16 inches in diameter over the table.


Internal Grinding Attachment.

The cross feed is operated by a hand wheel graduated to read in thousandths of an inch on the diameter of the work. Both ends of the spindle are tapered to receive wheel sleeves upon which the wheels are mounted. The spindle is carried in a slide which has a vertical adjustment upon the slide upright, the movement being made by a handwheel that is graduated in thousandths of an inch. The upright has a transverse movement of 10½ inches and is operated by the cross feed hand wheel above referred to. It swivels on its base which is graduated to read to 90 degrees on either side of the center line.



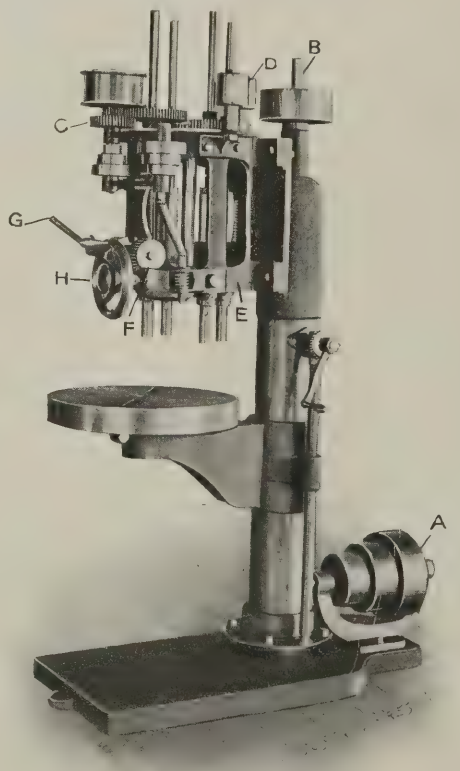
Some of the Applications of the Brown & Sharpe Universal and Tool Grinding Machine.

Numerous attachments are provided for increasing the scope of the work that this machine can accomplish. The internal grinding attachment on preceding page is made for grinding holes, either straight or tapering, from ¼ inch in diameter upward, and to 2¾ inches in depth. When in use this attachment is clamped to the front of the wheel slide by four bolts fitting in T-slots. The spindle is driven by means of a round belt running on a grooved wheel, that is placed on the right hand end of the main spindle. A circular grinding attachment is provided for grinding concave or convex cutters and work of a similar character, and a surface grinding attachment affords a means for grinding flat surfaces. This latter attachment comprises a wheel spindle extension, table plate and vise.

The group of photographs illustrates a few of the uses to which this grinder may be applied. Fig. 1 shows the internal grinding attachment employed for grinding a hole in a bushing. The bushing is held in a universal chuck mounted on the headstock spindle and revolved by the live center pulley. Fig. 2 shows the method employed for grinding the exterior surface of the same bushing, which in this case is held on an arbor revolving on dead centers. Fig. 3 illustrates the grinding of a double angle cutter, which is mounted on an arbor supported in the tool rest of the universal head. By swiveling the table, both angles can be ground without resetting the cutter. In Fig. 4 is shown a face milling cutter, held in the universal head, the teeth being ground on the sides by using a dish wheel. It will be noted that the tool holder is tipped at an angle to give proper clearance, and that the spindle slide upright has been turned through an angle of 90 degrees so as to present the end of the spindle to the work.

A MULTIPLE SPINDLE TURRET DRILL.

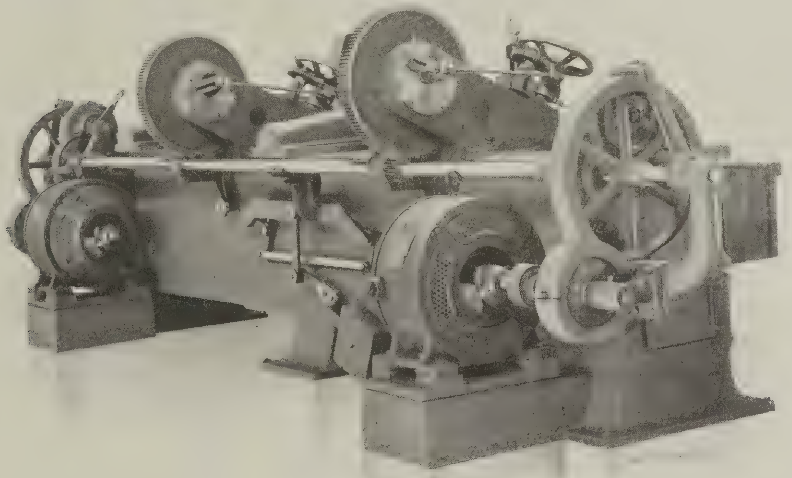
The accompanying half-tone illustrates a new turret drill, designed by Mr. S. A. Baker, and recently placed upon the market by the National Separator and Machine Co., Manchester, N. H. This machine is for drilling, tapping, reaming, etc., on duplicate parts without the necessity of changing the tool or the work. It is shown in the photograph as carrying four spindles but can be furnished, by the builders, with three, four, five, or six spindles, as desired, and with either power or lever feed. It is driven, from the countershaft, by the three-step cone *A* which operates the shaft *B*



Four-spindle Turret Drill.

by bevel gears. This shaft connects with the driving gear *C* by means of a belt which passes around the idler pulleys *D*. The turret carrying the spindle revolves in the casing *E* and is arranged so that when the desired spindle is turned to the front, the driving gear connects with that on the spindle and causes it to revolve while the other spindles are left back out of the way until they are to be used, when the turret is revolved to each spindle in its turn. It will be seen in the photograph that the same size gear is placed on all of the spindles but one and this is geared down to a slow speed for tapping and counterboring.

The spindle is fed down to the work by the worm and worm-wheel *F* and is arranged so that it can be moved down directly and quickly by the lever *G*, also by the handwheel in front, and by power by simply tightening the knob *H*. The spindles can all be set to stops and are counterbalanced. All of the tools work to the same point on the table and only one spindle, the working one, is revolving at a time. The locking pin is directly beside the spindle that is in use, and the moment power is applied the strain passes to the frame of the machine, the turret acting simply as a guide to the spindle.



Cincinnati Traverse Shaper with Electric Drive

ELECTRICALLY - DRIVEN DOUBLE HEAD TRAVERSE SHAPER.

The double head traverse shaper shown herewith has recently been supplied to the Locomotive & Machine Co., Montreal, Canada, by the Cincinnati Shaper Co., Cincinnati, Ohio. This machine is operated by two Westinghouse motors, which are arranged for the 2-voltage, 3-wire system and rated at 3 and 6 horse power at 115 and 230 volts respectively. The variation of speed of the machine is obtained through the variation of the motor, and also by back gearing on the machine, as may be seen through the large gear wheel on one of the two splined shafts at the back. This large gear wheel is driven by a pinion mounted on the motor shaft.

The two heads are driven independently, one from each end of the machine and as they are arranged to work at any point along the bed it is necessary that they travel past the center of the bed. Owing to the length of the splined driving shafts by which the heads are driven it has been thought best to provide a support at the center of the bed and the photograph shows the arrangement that has been made for automatically depressing this support when one or the other of the heads is passing the center of the bed. As stated, each head is driven independently by a full length driving shaft and the feeds to each saddle are also operated by independent full length screws. The travel of each saddle is 118 inches, the maximum distance between the tools 144 inches, and the minimum 26 inches. The total weight of the machine is about 14,000 pounds.

VARIABLE SPEED MOTOR DRIVE FOR PLANERS.

The half-tones, Figs. 1 and 2, illustrate a new motor-driven planer, built by the Cincinnati Planer Co., Cincinnati, Ohio, which is designed to give a variable speed to the cutting stroke and a constant return stroke at all times. It is adapted to the use of a standard constant speed motor which is mounted upon the top of the housings and from which the power is transmitted to the rear, or constant speed shaft, by a pair of spur gears, one of which is of rawhide to obviate any noise. This first or constant speed shaft carries the return shaft and consequently always gives the table the same speed for the return stroke. Upon this shaft is also mounted a heavy flywheel, to relieve the strain on the motor at the reverse.

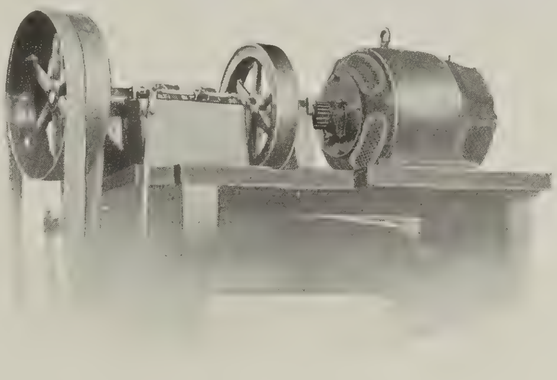


Fig. 1. Rear View of Variable Speed Planer Drive.

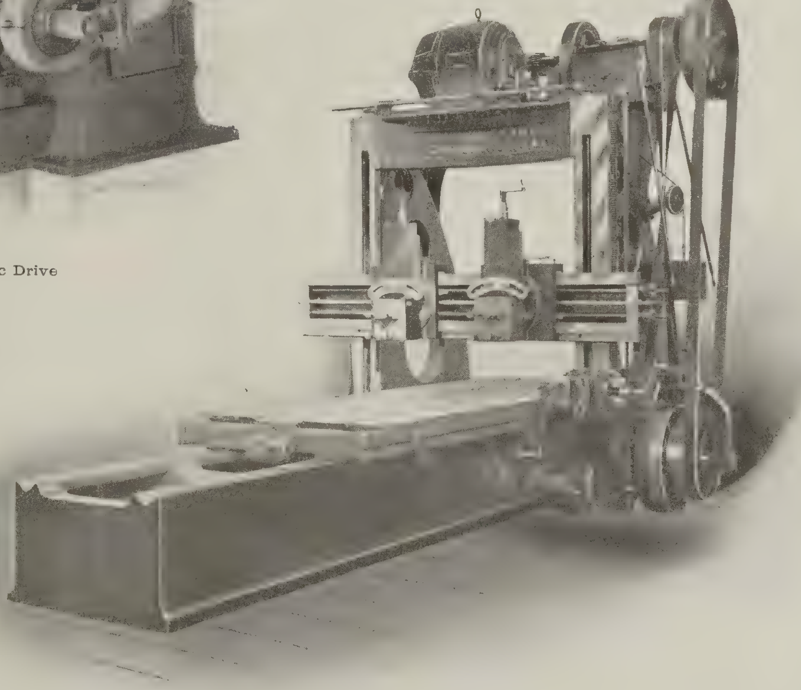


Fig. 2. Cincinnati Planer with Variable Speed Motor Drive.

The pulley for the cutting stroke is placed on a separate, or forward shaft, as shown in the front view, Fig. 2, and to it power is transmitted from the constant speed shaft by two trains of gearing, each giving two speeds, which consequently makes four cutting speeds available for driving the platen. The changes in speed are obtained by simply moving one or both of the levers shown on the side of the planer, and they may be made either while the machine is in operation or while it is standing idle.

The cuts illustrate this drive as applied to a 48 x 48-inch planer, but the builders state that the same style of drive has been applied to all the other sizes of planers which they manufacture. The speeds used on this machine were arranged for cutting at 20, 25, 30 and 36 feet per minute, with a constant return speed of 72 feet per minute.

HORIZONTAL BORING, DRILLING AND MILLING MACHINE

The Fosdick Machine Tool Company, Cincinnati, Ohio, have just placed upon the market the machine illustrated in Figs. 1 and 2, which is designed for both light and heavy boring, drilling, tapping, reaming, facing and milling, all of which operations are performed upon the work which is fastened to the table. The accompanying half-tone gives a view of the machine as seen from the operating side, while the line-drawing, Fig. 2, shows an end view and illustrates many of the details of construction.

The machine is driven by a splined shaft, which traverses the driving cone on the rear of the bed. The column, carrying the spindle head, has a horizontal movement on the bed, by hand or power, and a quick forward and return motion by power which is operated by a handwheel on the front of the bed. The spindle head is counterbalanced and provided with a safety chain. It has a movement on the column by hand or power, and for quick adjustment is operated through a rack and pinion by means of a pilot wheel on the front of the spindle head. The spindle runs in adjustable box bearings, and has a thread cut on its front part to receive chucks, large milling cutters, facing heads, etc. It is made to revolve in a right or left hand direction by the operation of a reversing lever. This is very convenient for facing, tapping or milling operations.

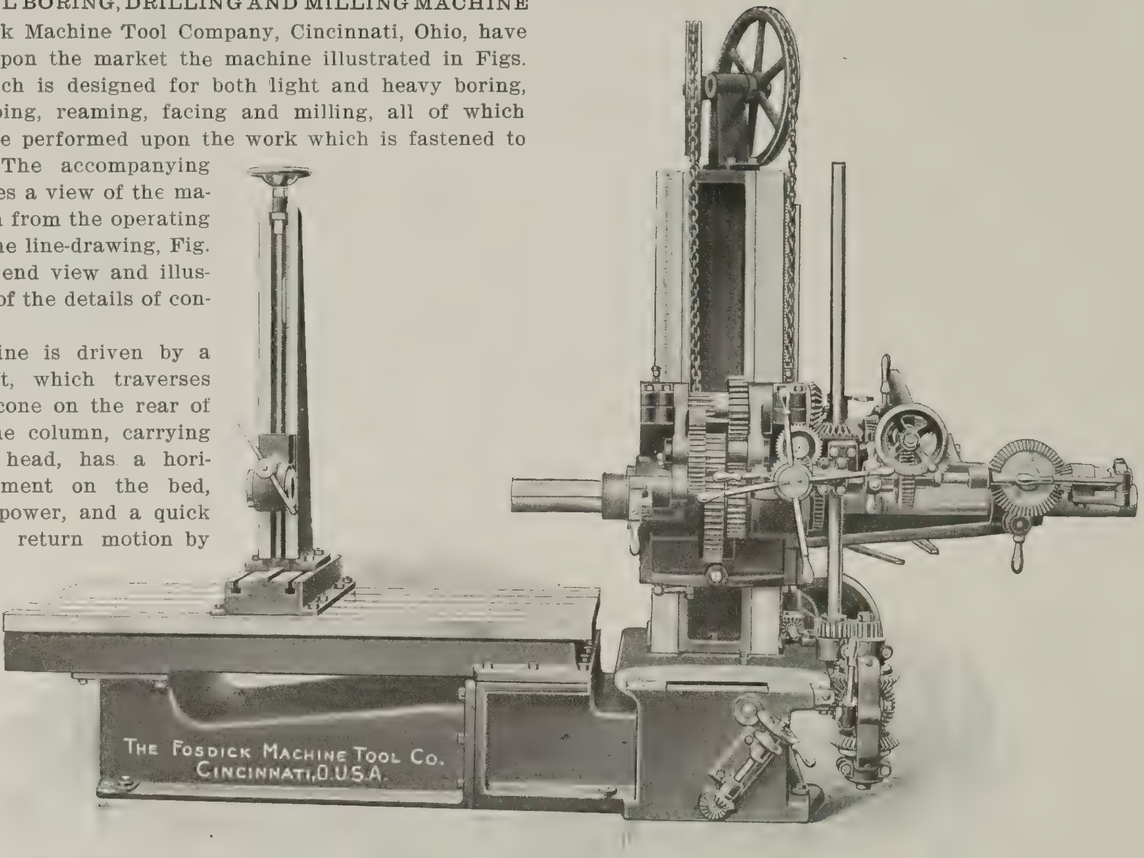


Fig. 1. Fosdick Horizontal Boring, Drilling and Milling Machine.

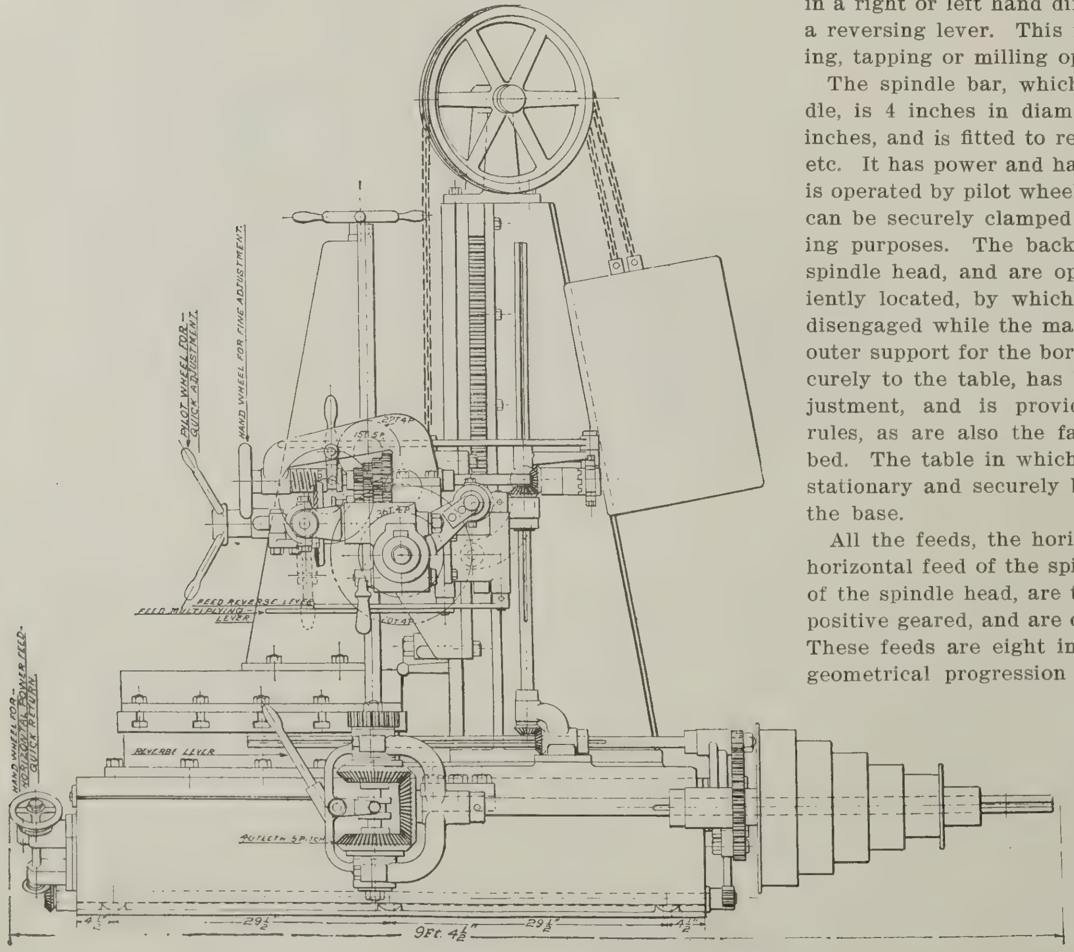


Fig. 2. End View of Horizontal Boring, Drilling and Milling Machine.

The spindle bar, which passes through the spindle, is 4 inches in diameter, has a traverse of 22 inches, and is fitted to receive drills, taps, reamers, etc. It has power and hand feed in both directions, is operated by pilot wheel for quick adjustment, and can be securely clamped when in use for face-milling purposes. The back gears are located on the spindle head, and are operated by a lever conveniently located, by which they may be engaged or disengaged while the machine is in operation. The outer support for the boring bar can be clamped securely to the table, has horizontal and vertical adjustment, and is provided with graduated steel rules, as are also the face of the column and the bed. The table in which the T-slots are planed, is stationary and securely bolted to both the bed and the base.

All the feeds, the horizontal feed of the column, horizontal feed of the spindle bar, and vertical feed of the spindle head, are taken from the spindle, are positive geared, and are operated by hand or power. These feeds are eight in number, and arranged in geometrical progression from .007 to ¼ inch per revolution of spindle; they are all reversible. The spindle speeds are ten in number, arranged in geometrical progression from 4 to 260 revolutions per minute. The total height of this machine is 8 feet and the length, over all, 10 feet 6 inches. The net weight is 12,000 pounds.

THE "QUEEN CITY" SHAPER.

The 16-inch crank shaper illustrated in Fig. 1 is especially designed for use with the high-grade tool steels and is furnished by the builders either with or without back gearing. The back gearing, when employed, is wholly enclosed within the column and is operated by a lever at the back. Fig. 2 shows a line drawing of this mechanism, and also shows the different trains of gears that are used for driving the bull wheel. The ram is of special construction, so designed as to lose none of its rigidity throughout the stroke. The connection of the rocker arm to the ram is of the link type, giving a straight pull on the cutting stroke and a quick return. The arm is provided with an adjustment to compensate for wear of the crank shoe.

The rail has unusually wide bearings on both top and bottom, and the adjusting gibs between the ram and the rail are firmly held by screws fitted with nuts flush with the casting. The head may be swiveled, over a graduated disk, to any required angle, and the down-feed screw is provided with a graduated collar indicating thousandths of an inch. The horizontal traverse screw is also provided with a similar collar. The table is of box form, having T-slots on top and side, and a *V* for holding shafts or similar work vertically. It can be readily detached from the apron. The vise has a graduated circular base, allowing it to be set at any angle, and it may be attached to the top or side of the table. An opening is provided under the ram so that shafts or pieces of any length similar may be passed through for key-seating. The length of the stroke can be quickly changed and locked from the working side without stopping the machine. The shaper is the product of the Queen City Machine Tool Company, Cincinnati, Ohio.

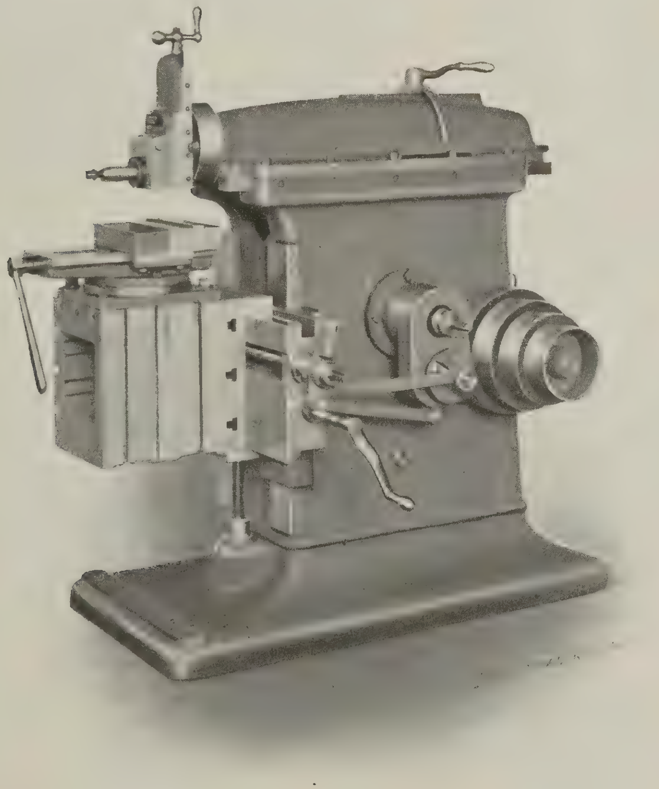
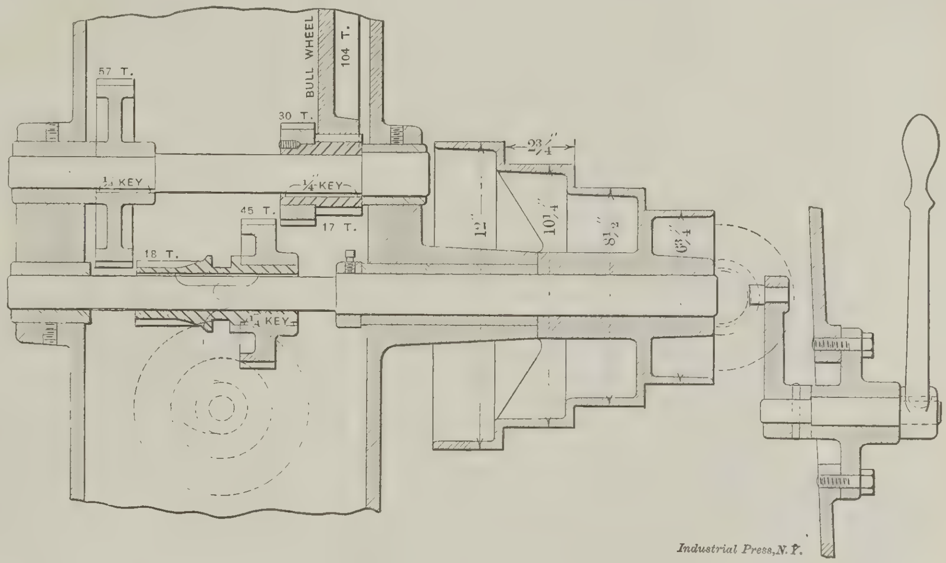


Fig. 1. "Queen City" Crank Shaper.



Industrial Press, N. Y.

Fig. 2. Back Gear Arrangement of "Queen City" Shaper.

NEW LATHE WITH ALL-GEARED HEADSTOCK.

The American Tool Works Company, Cincinnati, Ohio, have just brought out a new lathe, with all-geared headstock forming a unit to which any type of electric motor may be readily connected. The motor may be placed on the top or at the rear of the gear-casing. The changes of speed are produced by an arrangement of six gears, oppositely disposed on the spindle and driving shaft, which are engaged by means of levers placed in front of the speed box. In connection with a variable speed motor, on a 20-inch lathe, this mechanism provides for sixty spindle speeds, ranging from 5 to 322 revolutions per minute. The lever for the control of the motor is placed on the right-hand side of the carriage.

This same speed-changing mechanism is also adapted for belt drive, and will permit of a machine thus installed being converted into a motor-driven tool at any future time. In addition to the speed variator, the lathe is equipped with a rapid-change gear mechanism providing a wide range of changes for feeding and screw cutting, each change being available while the machine is in operation and without the removal of a single gear. The leadscrew is placed on the inside of the bed so that the pull on the carriage is directly under the cutting tool, and the half-nuts by which the screw is engaged and released are operated by a lever at the front of the carriage.

A NEW BENCH SHAPER.

A new crank shaper that is especially adapted to tool room and bench work has just been placed upon the market by L. E. Rhodes, Hartford, Conn. Taking into consideration that a large percentage of shaper work is small and of a light nature, coming well within the range of 7 inches, this length of stroke has been selected. The greatest distance from the table to the ram is also 7 inches. The driving arm reaches well into the interior of the ram and is connected by a link which is located at a point in a direct line with the greatest resistance of the cutting tool. The shaper is provided with ratchet cross feed and both cross and down feed screws have micrometer adjustment. The table is of box pattern, provided with a vise having quickly adjustable jaws and a swivel base graduated in degrees. Upon the driving shaft is mounted a three-step cone and also a handwheel. Although designed for a bench machine, it may be supplied mounted upon an iron stand if desired. It occupies a floor space of 22 x 24 inches, and weighs, with the countershaft, 290 pounds.

VERTICAL BORING, FACING, AND TAPPING MACHINES.

Figs. 1 and 2, next page, show two types of boring, facing and tapping machines that are the product of Baker Bros., Toledo, Ohio, and are designed for the heaviest kind of work in locomotive shops and shops manufacturing large steam fittings. The main spindle is driven by means of a cross arm in the housing shown on top of the driving gear. This arm is about three times the diameter of the spindle in length and is provided with broad bearing surfaces, which work in vertical grooves on either side of the housing. This construction avoids the excessive friction that is occasioned by the usual method of driving by means of a feather in the hub of the driving gear. The thrust of the spindle is taken on roller bearings.

The entire train of gearing employed is very heavy, the main driving gear being 28 inches in diameter by a 4-inch face, and 2 pitch. Triple back-gears are provided giving, with four steps on the cone pulley, twelve changes of speed. The ratio of gearing with the triple back-gears is 1 to 82. The twelve spindle speeds range from 2 to 45 revolutions per minute, and for each spindle speed there are six belt-driven feeds, varying from 0.54 to .003 inch per revolution of the spindle. In addition to the belt feeds the machine is provided with a positive geared feed which, by means of change gears, will give any feed from .07 to ¼ inch. These are arranged so that a positive lead corresponding to any number of threads from 4 to 14 may be obtained for tapping. The spindle, which may be made with either 14 or 20 inch travel, is provided in addition to the belt geared feeds above-mentioned, with lever feed, hand-worm feed, an automatic stop, and is counterbalanced.

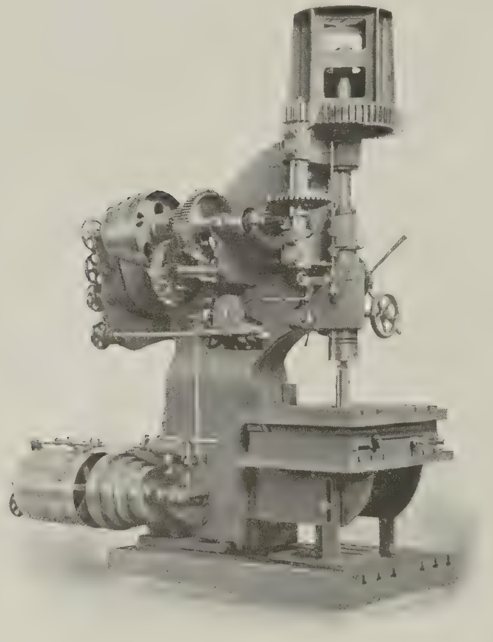


Fig. 1. Single Vertical Boring, Facing and Tapping Machine.

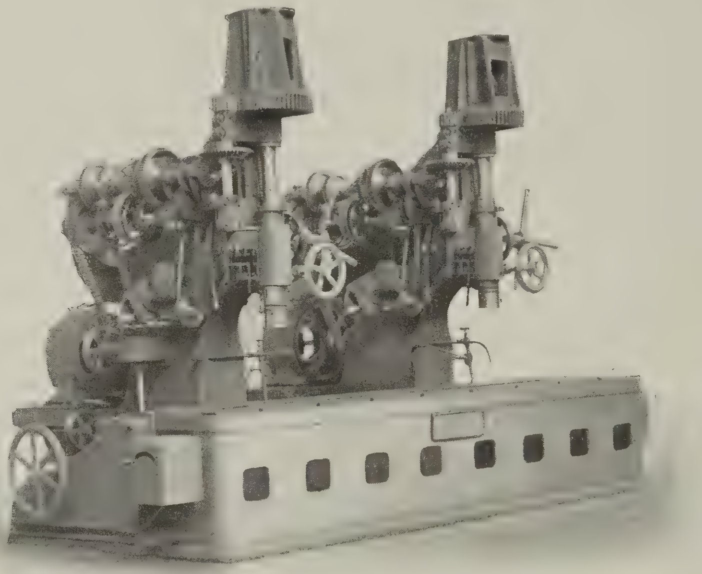


Fig. 2. Duplex Vertical Boring, Facing and Tapping Machine.

The machine is furnished with a compound table, 30x36 inches, which is placed under the regular table and is very handy for use in chucking work, as the piece may be clamped approximately in position and then, by means of the table screws, brought into line with the spindle or boring bar. This table has a right-and-left adjustment of 20 inches, and an in-and-out adjustment of 14 inches, and with it the machine may often be used to advantage for milling.

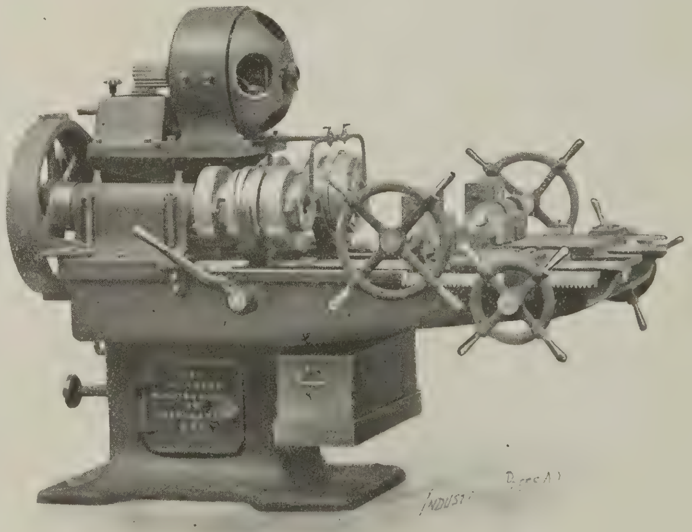
Fig. 2 shows a combination of two of these machines upon a single base, each spindle being driven by a 10 horse power General electric motor, by means of a Renold silent chain. The ratio of the gearing to the spindle is 175 to 1 and triple back-gears are employed which, being again compounded, give six changes of speed, varying from 3½ to 43 revolutions per minute. Intermediate speeds are obtained by means of speed control. There are twelve changes of feed positively driven by Renold silent chain and ranging from .1 to .005 inch per revolution of the spindle. Both frames are adjustable along the base, to vary the center distance, and the left-hand frame may be moved by power.

NEW 17-INCH LATHE WITH TURRET ATTACHMENT.

Greaves Klusman & Co., Cincinnati, Ohio, have entirely redesigned their 17-inch engine lathe and are placing it upon the market fitted with power feed automatic turret. In addition to the feeds of this turret, which are obtained by the usual cone pulleys, it has three changes of feed on the front side of the turret where they are directly under control of the operator by means of a lever placed near the pilot wheel. The lathe is provided with a five-step cone pulley for 2½ inch belt, and is strongly back geared. All feeds are reversed at the apron and arrangement is made for preventing the engagement of feed rod and leadscrew at the same time. The cross and longitudinal feeds, however, may be operated simultaneously. Provision is made for cutting threads from 2 to 48 per inch, including the 11½ pipe thread, without change of spindle gear, the change from right- to left-hand thread being made by a reversing lever at the headstock. There are four changes of belt feed, and gear feed is also provided, so that all feeds needed can be obtained with the feed rod, reserving the leadscrew solely for thread cutting. The countershaft has friction pulleys with a special arrangement for oiling without throwing off the belt.

A DUPLEX MOTOR-DRIVEN BOLT-CUTTER.

The accompanying half-tone illustrates a 2-inch double bolt cutter, with motor drive, that has just been brought out by the Reliance Machine and Tool Company, Cleveland, Ohio. This is the same as their standard machine, with the exception that the belt pulley is replaced by a motor, which is placed between and above the headstocks, where it is free from oil and chips and occupies no valuable floor space. A 3 horse power Crocker-Wheeler reversible, variable-speed motor is used, giving a speed variation of 3 to 8. A nest of gears placed between the pinion on the motor shaft and the main pinion of the machine increases this ratio to 1 to 6. By means of a Cutler-Hammer speed controller used in connection with the motor, eighteen spindle speeds are obtained. While this arrangement has proved so satisfactory as to be adopted as the standard drive for this machine, the builders inform us that they are prepared to furnish any other electrical equipment that may be desired, and connect the same either by direct gearing, belt or silent chain.

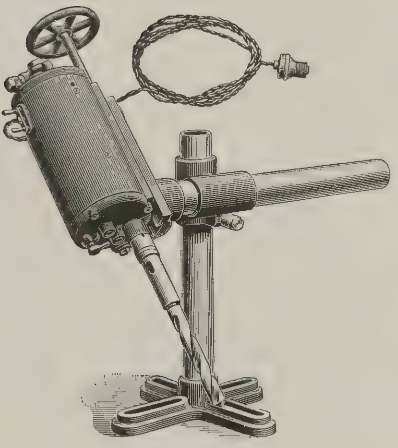

Two-inch Duplex Motor-driven Bolt Cutter.

PORTABLE ELECTRIC "SCOTCH" DRILL.

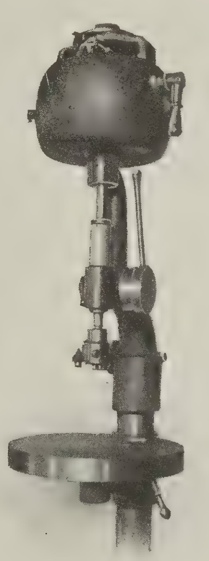
The portable, electrically-driven "Scotch" drill, illustrated herewith, is being placed on the market by the Hisey-Wolf Machine Co., Cincinnati, Ohio. This machine has a capacity for carrying drills up to 7/8 inch in diameter and has a feed of 7 inches by the handwheel. The adjustable bracket upon which the drill is mounted has a movement of 20 inches in any direction, making the machine universal. The drill has two speeds, the power being obtained from any incandescent lamp circuit where direct current is employed, the motor being wound for 110 and 220 volts. The motor is inclosed and dust proof and is suitably geared to develop the necessary power up to the capacity of the drill. The machine may be carried from point to point around the shop, its sphere of action being limited only by the length of the flexible wire connection. Its weight is 95 pounds and extreme height 30 inches over all.

TWELVE-INCH ELECTRIC-DRIVEN SENSITIVE DRILL.

A novel and very practical application of the electric motor for machine tool operation is illustrated by the 12-inch sensitive drill shown in the accompanying photograph. In this machine the motor is mounted upon the frame directly over the spindle and has a hollow shaft through which the spindle slides and is driven by a key. By this arrangement the power is applied directly to the spindle and none is wasted in belts, gears or friction wheels. The spindle has but three bearings, and as there is no side pull from belts or gears the wear is reduced to a minimum. Four speeds are provided, ranging from 500 to 1,500 revolutions per minute, all obtained by simply moving the starting handle, shown on the side of the motor, to different positions, which are clearly marked, to show the speed at each point. A higher range of speed may be provided for, if required. This drill is designed and built by James F. Willey, Jeffersonville, Ind., and is being placed upon the market by Jas. Clark, Jr., & Co., Louisville, Kentucky.



Portable Electric Drill.

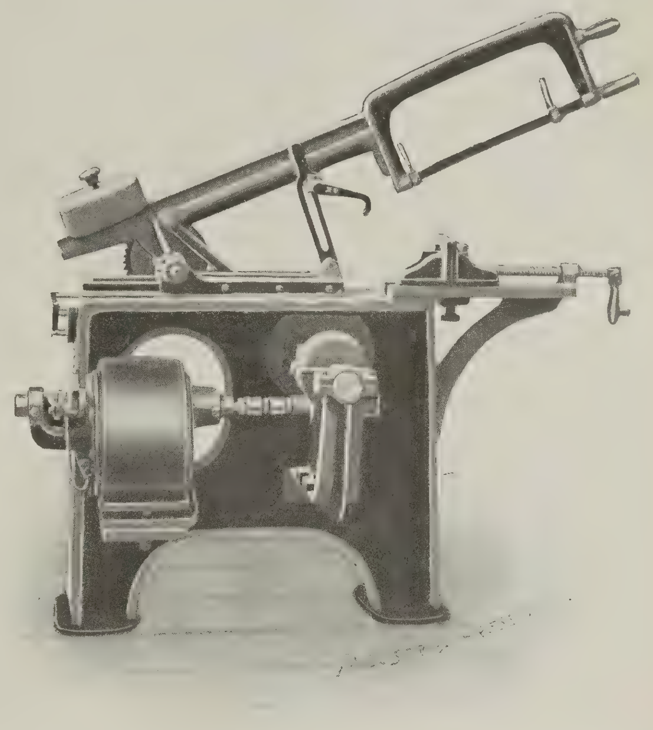


Sensitive Electric Drill.

MOTOR-DRIVEN HACK SAW.

The Patterson Tool and Supply Co., Dayton, Ohio, are equipping their "Challenge" power hack saws with motor drive, as illustrated in the accompanying cut, so that they may be used in stores or stock rooms where belt driving power is not available. The motor by which this saw is driven is made by the Sterling Electric Co., Dayton, Ohio, and is especially wound so that the usual rheostat or starting box is dispensed with, a knife blade switch on the back of the machine frame being used for starting or stopping. This switch is automatically thrown out at the end of the cutting. The motor is usually wound so that it may be connected with the ordinary electric light current and the saw operated through a worm and worm gear, but a slow speed motor and belt drive may be furnished if desired.

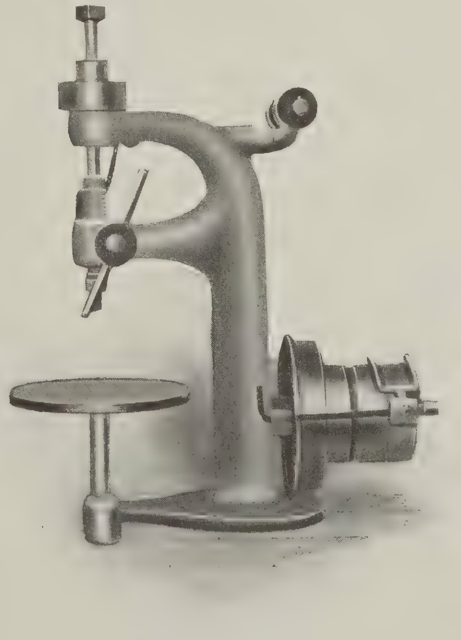
The saw has a capacity of 6 x 6 inches, and is fitted with a vise that is adjustable, forward and back, so that when one end of the saw is worn out the other end can be used. The friction arrangement, in connection with the sliding counterweight, gives a positive feed, but on the return stroke relieves the saw and prevents it from dragging over the work. The same machine may also be furnished with a pulley substituted for the motor and worm gearing and either type of saw can, when desired, be supplied with a raised arm, which makes it capable of cutting 12-inch I-beams, channels and similar work.



Electrically-driven Hack Saw.

NEW TEN-INCH BENCH DRILL.

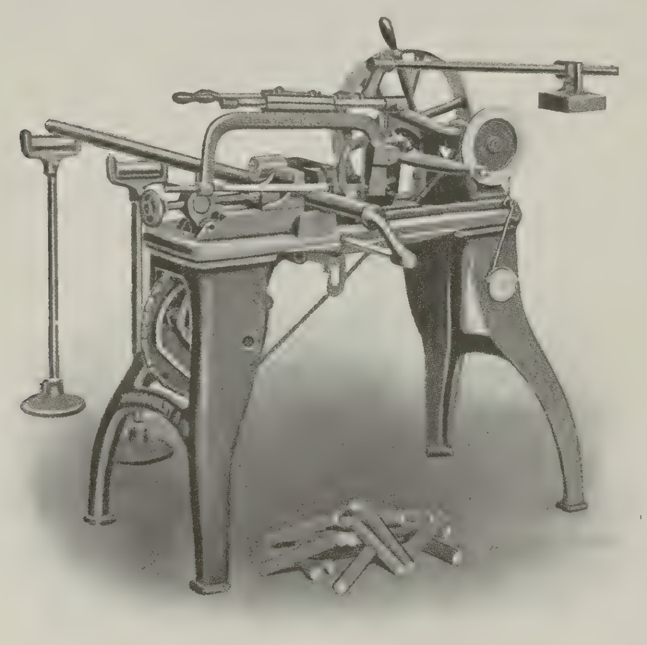
The Miami Valley Machine Tool Co., Dayton, Ohio, have just brought out the bench drill illustrated in the accompanying photograph, which, although following quite closely the ordinary lines of design of such tools, has been built with especial attention to simplicity and rigidity of the parts. The swing of the drill is 10 inches and it is provided with counterbalanced lever feed and a two-step driving cone. It is driven from the countershaft by tight and loose pulleys, having a belt shifter so located as to be readily accessible to the operator. The total weight of the drill is about 55 pounds.



Ten-inch Bench Drill.

AUTOMATIC HACK SAW.

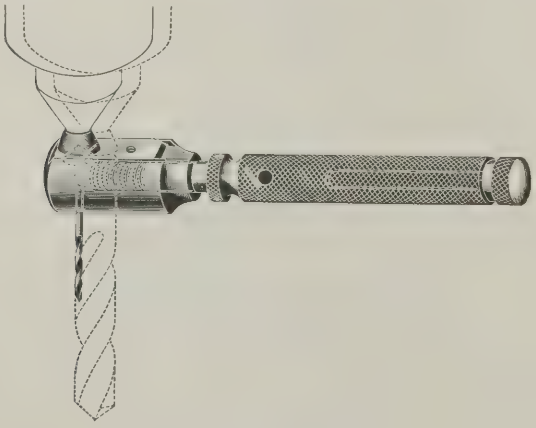
The hack saw which is illustrated in the accompanying photograph is a full automatic machine which cuts up bars or pipes into pieces of uniform length without any attention other than starting it upon the first cut. On the completion of a cut the saw rises, vise opens, the work is fed forward the required length and the vise closed. Then the saw falls and a fresh cut is commenced. When the bar has been entirely cut up a bell rings continuously until the machine is attended to. If a saw blade breaks the bell also rings for attention. The machine can be set for single cuts when the bell rings on the completion of the cut.


Automatic Hack Saw

No adjustment is required other than setting the gage for length, as with the ordinary saw. The length gage moves clear of the work while the cutting is in progress and so prevents the detached piece from jamming and breaking the saw. The counterbalance weight, by means of a simple mechanism, alters its position automatically to compensate for the blunting of the saw through use. The machine handles stock of any length and of any size and shape up to 4 inches. It is simple in construction so that it will not easily get out of order and may be operated by unskilled labor. It is being placed upon the market by Montgomery & Co., New York, N. Y.

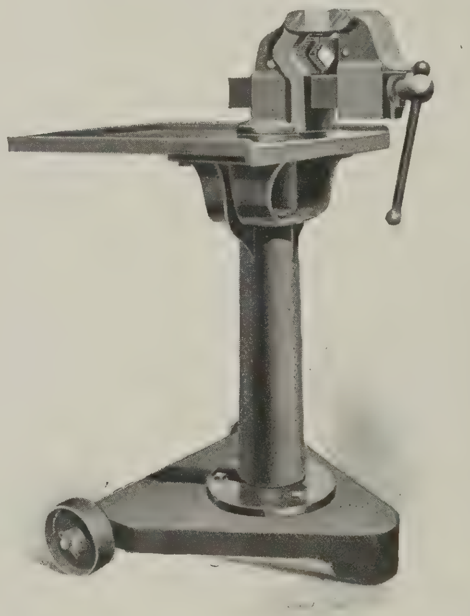
A HOLDER FOR SMALL DRILLS.

The little device illustrated herewith will be appreciated by any one having to use small drills in connection with lathe work. Ordinarily, drills up to one-half inch are pointed on the back end and in order to use them in the lathe this point must be ground off and a female center made on them, or else they must be held in a drill chuck fitted to the tailstock spindle. With this device small drills may be used without any alteration whatever. It consists of a holder in which the drill is secured by a few turns of the handle, while on the back of the holder is a floating female center into the inner side of which the pointed end of the drill fits and thus locates the center exactly in line with the point of the drill. The female center is then used with the tailstock center in the same manner as when using large drills. With this holder the operator is at all times able to tell the exact tension to which the drill is subjected and breakages are largely avoided. Inserted in the end of the handle is a small bar which may be removed and used for tightening the drills, by placing it in a hole drilled at right angles with the handle. The cut shows how the holder is applied to the smallest size of drill, while the dotted lines illustrate its application to the largest drill within the capacity of the machine. At present this holder is made to use drills from No. 60 up to 5-16 inch, but larger sizes will be made later. It is the product of the O. K. Tool Holder Co., Shelton, Conn.


Adjustable Drill Holder.

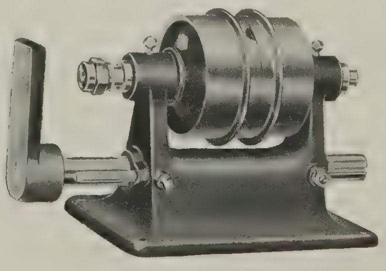
PORTABLE VISE STAND.

The Western Mfg. Co., Springfield, O., believing that it is sometimes the easier course to take the mountain to Mahomet, have just brought out a novelty in the way of a portable vise stand which is designed for moving around the shop to any place where it may be desired to do any filing or fitting. Thus, instead of having to carry piles of castings to a bench, the stand, which is in effect both bench and vise, is rolled to the pile of castings and as soon as that job is done it is rolled along to the next. The device consists of a cast-iron base and column, weighing about 225 pounds, and having mounted at the top a table 17 x 21 inches, and a regular machinist's vise which may be fitted with plain or combination pipe jaws. On two corners of the triangular base are placed wheels so that the whole device may be easily moved, while the third corner is formed into a substantial foot which prevents any movement of the device when it is in use.


Portable Vise Stand.

TAPPING DEVICE FOR SMALL WORK.

The tapping device illustrated below has just been placed on the market by Blomquist & Welander Co., Cleveland, Ohio. The driving pulleys run on hollow studs, thereby relieving


Device for Tapping Small Holes.

the spindle from all pressure due to the belt and making it very sensitive to the tap. The spindle is driven by a steel clutch working between the pulleys which are operated by open and crossed belts, thus insuring instant reversion. The spindle is also provided with a spring clutch with a long taper to give a perfect grip to the tap. The tailstock is mounted on a round steel rod which slides in the frame and is adjustable to any length of work. This device has a capacity for tapping holes ranging from the smallest up to ¼ inch in diameter.

* * *

FRESH FROM THE PRESS.

In our review of the book, "Iron, Steel and Other Alloys," published by Sauveur & Whiting, Boston, Mass., we stated that the price was $8.00. It should have read $5.00.

Gas Engine Troubles and Remedies, by Albert Stritmatter. Published by the Gas Engine Publishing Company, Goodall Bldg., Cincinnati, O. 112 12mo pages. Price $1.00.

The title of this book is an explanation of its contents, which consist of nine chapters, as follows: Gasoline feed supply; starting; fuel consumption; ignition; timing; two chapters on general troubles; lubrication; detecting trouble by sound. It is essentially a book on the care and operation of the gas engine, and will be found useful by those who have such engines in their care.

The Drafting of Cams, by Louis Rouillon. Pamphlet published by the Derry-Collard Co., New York. Price 25 cents.

This is No. 2 of the single-copy series of practical papers published by this company—the first being on the subject of tapers, as previously noted in these columns. The matter on cams which is given in this pamphlet is, in part at least, made up from articles by Mr. Rouillon for Machinery, and it is a concise and practical treatise on the subject, showing methods of laying out cams of various kinds.

Emery Grinding Machinery, by R. B. Hodgson. Published by J. B. Hodgson, Birmingham, England. For sale by J. B. Lippincott, Philadelphia, Pa. 180 12mo pages. Illustrated. Price $2.00.

This volume, it seems to us, would be of very little value to any American mechanic. It is a compilation of information and descriptive matter very general in character, and does not contain anything like the amount of practical information to be found in various technical articles that have been contributed to American mechanical publications. While it would undoubtedly assist a novice to an understanding of grinding machinery and processes we doubt if the practical mechanic would derive much benefit from its perusal.

Experiments on the Flexure of Beams, by Albert E. Guy. Published by the D. Van Nostrand Company, New York. 122 12mo pages. Illustrated. Price, $1.25.

The most, or the whole, of the matter in this volume first appeared in the pages of the *American Machinist*. It consists of a treatise on the flexure of beams and columns by a new analytical method based upon experiments. Mr. Guy has undoubtedly discovered some laws connected with the problem that have previously escaped investigation, and his discussion will be found an interesting and valuable acquisition to the science of the strength of materials.

Gas Engine Design, with an introduction on compressed air, by E. J. Stoddard. Published by Parker & Burton, Detroit, Mich. In large pamphlet form, 98 pages. Illustrated. Paper cover, 25 cents; cloth, $1.00.

The author states in a preface that the formulas in this work have received the approval of so many scientific men that he has presented it with confidence. The book has many drawings and consists of two parts—the first of which is a rather elaborate discussion of air when under compression or expansion, and the second relating particularly to proportions of the parts of gas engines. It discusses the dimensions of the cylinder to produce a given amount of power; the reciprocating parts; flywheel; valves; ignition apparatus, and general proportions. The treatment is mathematical—much more so than Roberts' well-known handbook.

Illustrated. Published by John Wiley & Son, New York. Price $1.50.

Electrical Engineering. Translated from the German of E. Rosenberg, by W. W. H. Gee and Carl Kinzbrunner. 267 8vo pages.

This book had its origin in a number of lectures delivered to the workmen and engineering staff of a large electrical firm, and the author states that the class of readers for whom the book is intended is the same as that to whom he lectured. It is designed to give to workmen, draftsmen, students and others a knowledge of electrical machinery and apparatus, and a good general education is all that is required to understand the treatment. We believe this volume fills this field satisfactorily, although it must be remembered it is a foreign work, not dealing with American apparatus to any extent. It has one merit in particular—that of treating alternating-current machinery, which is seldom taken up in elementary books of this character. It of course takes up continuous-current machinery, including generators and motors, and discusses electric lighting, accumulators, alternators, working dynamos in parallel, and high-tension currents.

Design of a High-speed Steam Engine, by J. F. Klein, Professor of Mechanical Engineering at Lehigh University. Published by D. Van Nostrand Company, New York. 257 pages, profusely illustrated with diagrams and tables. Price, cloth, $5.00.

The first edition of this book was published with the intention of making it Part 1 of a treatise on the dynamics and design of a high-speed engine, second part being planned to treat of the dynamics and design of shaft governors. This second part, proving to be too voluminous to be suited for undergraduate work in technical schools, it was decided to issue the two works independently, and the present edition of engine design is, therefore, presented without reference to the work on shaft governors. Much new material has also been added to that contained in the first edition, in the form of appendices. The arrangement of the subject is in the form of a problem in engine design. Stating at the start the conditions that would be given to the designer, the order of calculation then presents a systematic arrangement of the steps to be followed in consummating the entire design, and the succeeding chapters of the book are devoted to the investigation of each step in the calculations in the order in which they are outlined. The treatment is especially suited to the student who wishes to investigate the theoretical conditions governing the design of high-speed engines; and the treatment, which is thorough and clear, is confined strictly to this class of engine work. Solutions of the various problems involved are presented both mathematically and graphically. The chapters devoted to the subject of valve diagrams are unusually complete and are illustrated by numerous diagrams of the leading types of both single and double valves. In the appendix is a treatment of the subjects of the inertia resistance of the rod, determination of pin pressures and a chapter upon the subject of link motions including Stephenson's, Gooch's, and Allan's.

A Handbook on the Steam Engine. By Herman Haeder, and translated from the German by H. H. P. Powles, with additions and alterations. 458 pages, 1,085 cuts, and about 180 tables. Published by Crosby, Lockwood & Son, London; and D. Van Nostrand, New York. Price, $3.

That this book has proved to be quite a valuable one is indicated by the fact that the copy sent for review is of the third English edition. It is a work that should be appreciated by many mechanical engineers, designers, and draftsmen, especially those who care for European practice, as, with much other data, it gives a large number of tables of dimensions of Continental and English steam engines. The theoretical part has been treated briefly, and where formulas are necessary they are given, but are not intruded where there is no need for them. Following the historical notes the first section takes up the types of engines, giving outline diagrams showing arrangement of frames and cylinders; then follows the section on details, covering 118 pages. The section on governors is not so complete as it should be to attract the designers of American high-speed steam engines, but this is in a measure compensated for by the chapter on valve gears which gives in concise terms a great deal of matter regarding the leading types. The following sections are: Condensers, Air-pumps, and Feed-pumps; Examples of Engines of Continental Make from Actual Practice; Particulars of Engines by English Makers; Compound Engines; Indicators and Indicator Diagrams; Calculations for Power and Steam Consumption; Effect of Inertia on Reciprocating Parts; Boilers, etc. While a book of this nature always contains considerable obsolete matter and is necessarily behind the most advance engineering practice—a condition, by the way, that attaches to all engineering literature—it is, we consider, a good work for the library of the mechanical engineer and designer who cares to know the details of European precedents. We may add that all measures have been converted into English denominations.

NEW TRADE LITERATURE.

Jno. T. Burr & Son, Brooklyn, N. Y. Illustrated catalogue of the "Burr" cold saw, with full description of same.

E. G. Smith, Columbia, Pa., announces that he wishes to sell his filter business in order to devote all his time to his line of fine tools.

The Boston Gear Works, Boston, Mass. Catalogue "P" of gear specialties for 1903. Bevel, spur and internal gears with teeth planed theoretically correct, also spiral and helical spurs are there listed.

Wyman & Gordon, Worcester, Mass. "A Short Story of Elias Howe." This is a sketch of the life of the great inventor of the sewing machine. Also leaflet illustrating the drop forgings manufactured.

American Steel & Wire Co., Chicago and New York. Pocket catalogue, May, 1903, of the "Juniata" horse and mule shoes and toe calks, which are manufactured of iron or steel, are of different weights and for many purposes.

The Crocker-Wheeler Co., Ampere, N. J. Pamphlet illustrating the Crocker-Wheeler railway generator. Three fine half-tone views of the field, the armature and the brush rigging are shown, with brief description of each.

The Williamson Mfg. Co., Bradford, Pa. Folder illustrating and describing the "Williamson" vise. By one motion of the hand, pulling the lever forward, the jaws can be moved to right or left, up or down, forward or backward.

The C. W. Hunt Co., West New Brighton, S. I. Illustrated circular of coal tubs and contractors' tubs for the prompt handling of coal. They also make a special "side catch" tub for handling gravel, stone, sand, clay, mortar, concrete, etc.

The Yale & Towne Manufacturing Co., 9-15 Murray Street, New York. Pamphlet illustrating the "Triplex" hoisting blocks, for use in warehouse, press room, erecting shop, machine shop, boiler works, etc., in fact for all hoisting purposes.

The Emerson Electric Manufacturing Co., St. Louis, Mo. Small folder just from the press containing much condensed information about small induction motors. This is to supplement the Emerson bulletins already issued, all of which are sent on request.

The Sawyer Tool Co., Fitchburg, Mass. Illustrated price list of fine tools and hardware specialties. This supersedes all previous matter issued by the company and those writing for it should ask for "Catalogue F."

The R. D. Nuttall Co., Pittsburg, Pa. Booklet calling attention to the Nuttall motor gears and pinions. This company is occupied with the manufacture of gears only, and the booklet illustrates street railway motor gears from small size to 30 feet in diameter.

The Rand Drill Co., 128 Broadway, New York. Circular No. 10 of "Imperial" piston air drills, piston air wood boring machines, pneumatic hammers, etc. Examples of the work done—that is, reaming, tapping, flue rolling and wood boring—are shown, together with the tools used.

The Standard Welding Co., Cleveland, O. Illustrated catalogue, pocket size, of seamless steel tubing for all purposes. This shows only a part of the large line manufactured. Standard steel rims, clincher rims, bicycle parts are listed, and samples of electric welding are shown.

The J. Morton Poole Co., Wilmington, Del. Circular describing and illustrating the company's new line of vertical boring and turning mills, which are shown in our last number. These are made in the following sizes: 6-foot, 7-foot, 8-foot and 10-foot, and they state that they are preparing to build larger sizes of regular and extension boring mills.

The Joseph Dixon Crucible Co., Jersey City, N. J. Booklet entitled "An Index to Find the Fact you Need to Know," meaning, of course, facts about pencils for all possible uses. It explains what pencil is best suited to the work to be done, and no less than 54 pencils are described for merchants, metal workers, office workers, railroad companies, etc.

The Boston Gear Works, Purchase and Pearl Streets, Boston, Mass. Catalogue "P" and price list of gear wheels and gear cutting of every description. This treats of bevel, spur and internal gears with teeth planed, and of spiral and helical spur gears for smooth running or for high speeds. Besides the advertising matter contained herein there is considerable information and a number of tables on gearing, which will prove useful.

The Graham Manufacturing Co., Providence, R. I. Booklet calling attention to the "Universal" jig vise for use in plain and duplicate drilling. The company state that this saves time in the changing of pieces, and the jig attachment furnished enables the operator to drill as accurately as with a special jig. By using a simple drilling plate the vise may be used for drilling several holes in definite relation to one another.

The Emerson Electric Manufacturing Co., St. Louis, Mo. Bulletins Nos. 3041, 3042, and 3044, of direct-current power motors, direct-current motors and of polishing and grinding motors respectively, with considerable data regarding each type. The company manufacture alternating-current desk, bracket, ceiling and column fans; direct-current exhaust fans and power motors; alternating current power motors, pressure blowers, forge blowers, water pumps, etc.

The Pittsburg Blueprint Co., Pittsburg, Pa. Catalogue of electric blueprinting machine. Type A is the machine with upright wall; type B with tilting wall; type C with upright wall and automatic; type D with tilting wall, and automatic. Self-contained machines, types E. F. G. and H, are shown. The "Imperial" blueprint wringer —an improved apparatus for the purpose—which is driven by a small electric motor is also illustrated. This is built in three sizes, for rolls 34, 40 and 46 inches long.

The Consolidated Press & Tool Co., 96-100 N. Clinton Street, Chicago, Ill. Bulletin No. 1 describing a new line of power presses recently gotten out by this company. These are of the inclinable, open-back type, and possess a number of new features which are here described. Various styles and sizes of this machine are made, and the company also build presses for other work, such as wiring, blanking, punching, notching, etc., and special machinery for the manufacture of metal specialties.

The Billings & Spencer Co., Hartford, Conn. Pamphlet descriptive of small tools such as sportsmen's knives, magazine screw drivers and knives, adjustable pocket wrenches, combination pliers, an improved key ring, etc.; and drop forgings and machinists' tools. Also leaflets illustrating by line drawings the Lemoine front axle forgings for 1½-inch automobile axle, designed mostly for touring cars of from 12 to 30 horse power. Circular and price list will be furnished on application.

The Northern Electrical Mfg. Co., Madison, Wis. Crane motor Bulletin No. 32, of steel crane motors specially adapted to the requirements of crane service. This is electrically-driven, doing away with belts, is of the enclosed, dust-proof type, with bosses on the side for conveniently fastening to any required mechanism. The motor and its parts are illustrated and described at length, and on the front page is a view of Machine Shop No. 2 of the Northern Electrical Mfg. Co., showing their crane equipped with these motors. A cut also shows a "Northern" type of generator mounted on an Atlas Corliss engine.

The Cincinnati Machine Tool Co., Cincinnati, O. Standard size catalogue 1903, of upright drilling and tapping machines. These range from 21 to 42 inches in swing and a number of them are being built with the company's patent geared tapping attachment, by the use of which the operator can tap right and left-hand threads equally well, and which can be disengaged when not required. Among the new things are their motor-driven drills and their drills with compound tables and geared revolving tables. The catalogue is profusely illustrated.

E. G. Smith, Columbia, Pa., has issued a circular whose purport is that a number of his calipers, all sizes and styles shown in his catalogue, have become slightly shopworn from being exhibited, which he will dispose of at less than actual cost. A few hundred "Which Way" pocket levels only slightly rusted, but which will wear bright if carried in the pocket, are for sale at 25 cents each. Also parallel strips one-half inch square and any length up to thirty inches, can be purchased at 2 cents per inch in length. The circular also shows a combination micrometer which any mechanic can construct himself, either singly or in quantities.

Boynton & Plummer, Worcester, Mass. Catalogue and price list No. 2 of shaping machines, and upright hand and power drills. The catalogue is illustrated and, it seems to us, covers the line of tools manufactured very thoroughly. Traverse head shapers, upright self-feeding drills, upright bench drills, upright power drills, overhead or hanging drills, horizontal drills, self-feeding swivel clamp drills, bolt cutters, and nut tappers, tire benders and shrinkers, various types of forges, etc., are listed. Twenty-eight pages are devoted to an illustrated list of duplicate parts, for repairs to the company's machines, by the use of which they may be ordered by name or number.

The Ajax Manufacturing Co., Cleveland, O. The "Ajax Brown Book," 1903, of "Ajax" forging machines. The Ajax Company are the sole manufacturers of this machine, which is the invention of Mr. J. R. Blakeslee. It has recently been improved and a number of important features added, and is here illustrated and described, and samples of the work turned out are shown in half-tone views. It is built for work ¾ inch, 1, 1½, 2, 2½, 3, 3½, 4, 5, and 6 inches. Other tools shown are bolt-heading and open die rivet machines; automatic feed rivet machines; forging rolls; bulldozers; hot pressed nut machines; and a multiple spindle drill. Also a special axle machine with large die opening, made in any size. A number of useful tables appear in the back.

The International Mining Directory, 1903. Price $10.00. This publication, containing 523 pages, gives concise and reliable data regarding location, ownership, management, character of ore, development, equipment, etc., of the principal operating mines and metallurgical plants in Western United States, Mexico, South and Central America, Canada, Africa, Australasia, India, Japan, Korea. The book should prove exceedingly valuable to any interested in the subjects of mining and metallurgy, comprising as it does the names of all the reputable concerns engaged in the operation of mines or in the building of mine machinery. It is published by the Western Mining Directory Company, Denver, Colo., and San Francisco, Cal.

The Newton Machine Tool Works, Inc., Philadelphia, Pa. Catalogue No. 36, standard size, of machinery for army, navy, railway and general machine shop equipment; also engineering specialties in metal-working machinery. This is a catalogue of 236 pages, and is most complete. It lists plain milling machines, special milling machines for railway work; ten sizes and varieties of duplex milling machines; vertical slabbing machines; universal milling machines; rotary planing machines, with fixed heads, and swiveling heads; portable combined milling, drilling and boring machines; slotting machines; cold saw cutting-off machines; floor boring machines; a large variety of boring machines. All of these are illustrated, and the nature of the work for which each machine is specially designed is mentioned. A keyseat milling machine is shown, with two spindles, for keyseating shafting, which is an improvement on the usual method of keyseating, and secures a perfect keyway. This method is explained and illustrated in the catalogue.

The American School of Correspondence, Armour Institute, Chicago, Ill., have recently issued a catalogue containing much information of interest to those who are giving any attention to correspondence instruction. This method of securing an education is growing more and more popular, filling, we are told, a real want; and the School has, besides its large number of students here, quite a number abroad—even including the Fiji Islands, the Falkland Islands, and 300 students in New Zealand alone. The instruction is under the direction of members of the faculty of Armour Institute of Technology; and Dr. Gunsaulus, president of that Institute, has given the work his enthusiastic support and personal supervision. Due credit for the work covered by correspondence will be given any student who, later, may wish to pursue his studies at Armour Institute. The instruction papers are prepared especially for home study and a true indication of their value is the fact that they are used as text books in some of the universities and other educational institutions of this country. The catalogue contains also a list of the instructors, text-book writers, the Advisory Board, and of the School's graduates.

Charles A. Schieren & Co., New York. Illustrated pamphlet entitled "The Art of Tanning and Currying Belt Leather." This is a brief but interesting record of the history of tanning, and gives an account of the art as practiced at the company's "Dixie" tannery, Bristol, Tenn. A description is given of the preparation of the rock oak bark which is used in the process of tanning, a number of half-tones showing the machinery used, etc. Then comes an explanation of the manner in which the hides are prepared for the tanner, one feature being the "stuffing" of the leather with cod oil and pure beef tallow, which preserves the belt and makes it strong and durable. The company state they were the first to make a rivetless belt, joined only by cement, which prevents slipping. Their other products are their "Excelsior" belt, made with an extra dressing that renders it waterproof; their "Electric" belt so treated as to prevent its being damaged by mineral oil; their "perforated electric belt," specially made for all electric light and street railway service; and special wide main driving belts for factories and mills. Some of their larger sizes of belts are: 101 feet long by 60 inches wide; 112 feet by 58 inches, 160 feet by 60 inches, and 165 feet by 78 inches, and are made to stand the most trying service. The company's New York office is 79 Cliff Street.

MANUFACTURERS' NOTES.

Mr. P. E. Montanus, president of the Springfield Machine Tool Co., Springfield, O., and secretary of the American Tool Builders' Association, is running for Congress in his district.

The Miami Valley Machine Tool Co., Dayton, O., are offering a cash prize of $25 for the best design submitted to them on a taper attachment for their new 13½-inch lathe. Details will be furnished on application.

The Diamond Drill & Machine Co., Birdsboro, Pa., have opened an office in Pittsburg, in the Farmers' Bank Building, in charge of G. B. Nutt, the Pittsburg representative of Pilling & Crane; Pilling & Crane being their Pittsburg agents.

The Niles-Bement-Pond Co., London, Eng., branch, report that on October 3, Mr. W. S. Accles, their European manager, and Mr. G. T. Reiss, chief engineer at the Hamilton, O., works of their company, were received by the King of Spain, at San Sebastian.

The Ingersoll Milling Machine Co., Rockford, Ill., are building a new erecting shop of concrete, 55x200, and 30 feet high in the clear, equipped with a Pawling & Harnischfeger crane, motor drives to all machines, and other modern appliances. The new building, it is expected, will be ready for occupancy in December.

The Reeves Pulley Co., Columbus, Ind., are just completing a new pattern shop, 22 x 60 feet, two stories high. Their new foundry is now in operation. They recently had a large order for variable speed transmissions for the new plant of the Alma Portland Cement Co., Wellston, O.

Schuchardt & Schutte, importers of American machine tools, announce that in addition to their houses in Cologne, Berlin, Brussels, Vienna, St. Petersburg, Stockholm, and New York, they have just opened two more branch houses—one in Paris, France, Rue Reaumur 85, and one in Bilboa, Spain, Gran Via 29.

E. W. Roberts, designer and consulting engineer, who is well-known to the gas engine trade and is the author of the "Gas Engine Handbook" and other works on gas engines and automobiles, is fitting up a laboratory at Clyde, O., for the testing of gas and gasoline engines and gasoline automobiles, as well as for calorimetry and the analysis of both gas and liquid fuels.

The Huetter Machine & Tool Co., 418 So. Pennsylvania Street, Indianapolis, Ind., announce that they have a fine tool plant, equipped with machinery for the manufacture of fine tools, dies, model work and first-class special machinery of all kinds, at reasonable prices. They will be glad to give to anyone interested, prices on anything in their line.

M. H. Treadwell & Co., Lebanon, Pa., report that the outlook for business is very bright and that their plant will, in all probability, run at its full capacity during the entire winter. Their plant covers seven acres of land and their machine shop is equipped with the latest types of machinery. Since the incorporation of the company in January, 1901, the output has been practically doubled. An electrical department has recently been installed.

James Bonar & Co., Inc., Pittsburg, Pa., have taken over the business heretofore known as James Bonar & Co., and will continue to manufacture and handle a full line of first-class steam appliances. They are erecting a new machine shop and brass foundry for the manufacture of their own specialties and for other machine work. The shop will be equipped with new machinery of modern design, specially adapted to the manufacture of special work.

The Indianapolis Blue Print Co., 142-148 N. Illinois Street, Indianapolis, Ind. Illustrated catalogue of architects', engineers' and draftsmen's supplies. This catalogue is very complete, containing 254 pages, and includes everything in this line of goods. An eight-page index appears in the back. The price of the catalogue is 25 cents, but it will be sent prepaid without charge to professional architects and engineers.

The Norwalk Manufacturing Co., Norwalk, O., successors to the Baker & Wilson Machine Co. and the Norwalk Foundry & Machine Co., have issued a preliminary catalogue calling attention to the line of standard bolt cutters and nut tappers and dies which they manufacture. They announce that they are extending this line in many particulars and will illustrate and describe their products as opportunity permits. The pamphlet we have shows their ¾-inch and 1½ and 2-inch bolt cutters with automatic opening head.

The American Machinery Co., Grand Rapids, Mich., are just putting on the market a new type of band saw especially designed for patternmakers' work. They have already received orders for these band saws from the N. Y., O. & W. Ry.; the Exeter Machine Co., Pittston, Pa.; the Crocker-Wheeler Co., Ampere, N. J.; the Westinghouse Electric Co., Pittsburg, Pa.; and the Ruemmell, Dawley Manufacturing Co., St. Louis, Mo. They also report a very satisfactory trade on their other larger machines. They have just furnished the Washington Navy Yard, 24-inch hand jointer; the Portsmouth Navy Yard, Oliver universal saw bench; Santa Fe Ry. Co., 4 saw benches, 1 hand jointer and 3 bench trimmers; Erie Ry. Co., saw bench and 2 bench trimmers; Southern Florida Ry. Co., saw bench and hand jointer; Grand Trunk Ry. Co., saw bench, all of which are of the Oliver type.

The Norton Emery Wheel Co.'s (Worcester, Mass.) employees extended to Mr. Charles L. Allen, the secretary and general manager, a welcome home from his recent European trip on October 8. The entertainment took place in the immense works at Barber's Crossing, which were handsomely decorated with autumn foliage and occasional flags. A heavy silver cup was presented to Mr. Allen who, during the evening, shook hands with every one of the 400 employees. A light lunch and other refreshments were served and there was quite an attractive musical program. Among other features were a boxing match, in which we are told no blood was shed and which afforded much amusement. Also a series of stereopticon views showing Mr. Allen, Mr. Norton, the inventor of the emery wheel, the old time employees and those of the present day, the old shop and the new works—all of which were of considerable local interest.

MACHINERY.

December, 1903.

TOOL MAKING.—1.

A WORD TO THE BEGINNER—CUTTING SPEEDS—REAMERS.

E. R MARKHAM.

E. R. Markham.

IN many shops the term "toolmaker" is unknown, or, if known, is seldom used; the term "machinist" is applied to the class of men doing the general machine work, as well as to those making jigs, fixtures, gages, and cutting tools.

Until the advent of interchangeability of the parts of machines and of other products of machine shops, the use of jigs, fixtures, etc., was not generally known. The work was done mostly by what was then termed skilled labor and even then the assembling of the article was done by skilled workmen, because it was necessary to fit the various parts to each other.

It was found that by the use of suitable fixtures, jigs, etc., to hold the work and guide the cutting tools, work could be made to gage, which, of course, facilitated matters very much when the article was assembled. As this system of working was perfected, it was found that if these fixtures, jigs, etc., were made sufficiently accurate the various machining operations could be done by other than skilled workmen, thus materially reducing the cost of manufacture. As these men became accustomed to the work they were doing, they could, by the aid of accurate gages, produce work that could be assembled by unskilled help much faster and in a more satisfactory manner than it was formerly possible with skilled labor.

But in order to make the fixtures, jigs, gages, and cutting tools sufficiently accurate to produce work of the desired quality, it was necessary to educate the machinist to a point where he could do the work more accurately.

The system of interçhangeability of parts was not a thing to be accomplished in a minute; it has been a gradual development that took over forty years, and is to-day far from being realized in many shops.

The machinist who has had this higher education is generally termed a toolmaker. In large shops where there is enough work of one kind to keep a toolmaker busy, one man is given the gages to make, another the jigs, another the dies, and another the models. These men are then called gage makers, jig makers, die makers, and model makers, respectively. The object attained is that a man working on one class of work all the time will be more skillful in this one line than if he were working on various classes of work. In most shops, however, it is expected that the toolmaker will make all the fixtures, jigs, models, and cutting tools. The fact that, generally speaking, there is enough tool work to keep a toolmaker occupied all the time, has led some men to learn to make tools without learning the trade of machinist; but, however skillful this man may be, he is handicapped, because he may at any time be called on to build *special* machinery. This is generally considered work that should be given a machinist who has the experience of working on tool work, and unless a toolmaker understands the principles involved in machine construction he is liable to slip up, no matter how skillful he may be as a workman.

Machinery used in the construction of tools, as well as that employed in their use, has changed very much during the past forty years; yes, even within the last ten years there have been many radical changes which tend to make more practical the construction of tools used in producing duplicate work. And not only has machinery been perfected, but measuring tools are now built that make it possible to work within a limit of variation that was not dreamed of a few years ago. As measuring tools have been perfected, methods have been devised whereby work can be done very accurately, in less time than it was formerly possible to do a half passable job.

In constructing special machinery, fixtures, jigs, etc., it was formerly the custom in many shops to give a man a piece of work, or a templet, describing to him roughly what was wanted, and letting him go ahead himself and make the article. Everything was done by a "cut and try" method, and the result was often anything but satisfactory, both as regards practical utility and cost of construction. To-day the custom in most shops is to make drawings of all tools of this character, the drawings, or at least the designing being done by one man. These all agree as to working dimensions and working or locating points. How common it was under the old system to find a drill jig designed so that the piece of work was located from a certain point or surface, and the milling machine or other fixture designed to locate from an entirely different point, thus making it impossible to produce duplicate work!

Where one man makes designs for all the tools that go with a certain piece he makes them so that the working points of his jigs, fixtures, and gages agree; and when it is necessary, for any reason, to change a locating point he makes sure that in so doing he does not undo all he is attempting to accomplish and for which he is to build costly tools.

To attain success as a toolmaker a man should have a certain amount of education. He must be able to read a drawing, he must understand decimal fractions, and must be able to add, subtract, multiply, and divide both whole numbers and decimals. Right here I think I hear some one saying that "one of the best workmen he ever knew couldn't add 3 and 2 and get the proper answer—to say nothing of decimals." Well, what a valuable man this fellow would have been had he had a good education!

I recall a man who was in my employ for several years, who was an excellent workman, yet he could not take a drawing and work from it without having it explained to him, and as to anything that involved a knowledge of arithmetic, he was all at sea and some one had to do it for him. This man often deplored his lack of knowledge, and said he "would give a good deal" if he could take a drawing and figure out the calculations necessary to a proper understanding of it.

The man who wishes to become a successful toolmaker should also learn to work *accurately*. Accuracy is very essential in places where it is necessary; yet undue accuracy is never to be indulged in, because it consumes valuable time. If within 1-16 inch is near enough, it is folly to spend the time necessary to work within a limit of variation of 1-10,000 inch. But there are places where the latter limit of variation—or even less—must be observed, and in such cases the required time must be taken to do work of this character.

The successful toolmaker discriminates between the portions that must be approximately correct and those that must be exact, and governs himself accordingly.

As an example of the two classes of measurements under consideration, we will take a plug gage like that shown in Fig. 1. Now, it is essential that the portion marked *A* be *exact size*. The utmost care must be exercised when grinding and lapping to size, as no variation from the size given would be allowable. But when machining the portions marked *B* and *C* no such accuracy is necessary, neither is it desirable that time be spent on these to get them accurate within a limit of variation of 1-32 inch. Not that any such variation as this should be indulged in when dimensions are given, but the variation mentioned would not in any way affect the accuracy of the tool or its efficiency as a gage.

For the benefit of the beginner let us consider a few points that must always be observed if we want satisfactory work. The center punch should have a good sharp point, which should be at an angle of about 60 degrees. This angle is given not because absolutely essential, but because it is generally customary to make at about this angle, and it is always best for the beginner to have something definite to work to—it tends to make him a more careful workman.

He should be careful as to the condition of his center reamer, which should not only be sharp but should be exactly the shape of the centers of his lathe—generally 60 degrees.

It is impossible to do accurate turning if the countersinking in the end of the piece to be turned does not fit the lathe center. Fig. 2 gives two views showing the results when the countersink is not the same shape as the point of the center.

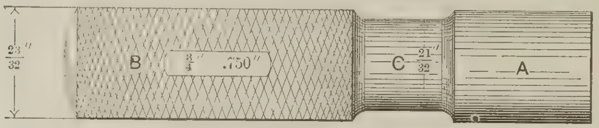


Fig.1

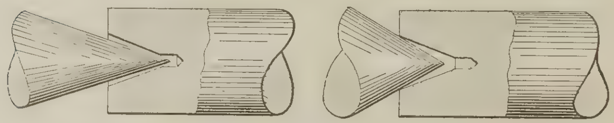


Fig.2

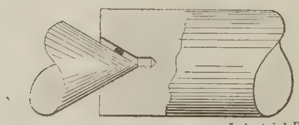


Fig.3

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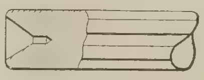


Fig.4

It is also highly important that the centers of the lathes fit well in the spindles, that they fit the center gage accurately, and that the live center runs true. It is especially necessary when the finish cut is taken on a piece. Many toolmakers never think of taking a finish cut after roughing without truing up the live center; or, if they find it necessary to remove the live center from the spindle, they always true it after returning to place before taking any finishing cuts.

Another precaution that is sometimes neglected is to always be sure there is no dirt in the spindle hole, or on the shank of the center before it is put in place. Then, again, he should always make certain that there is no dirt in the countersunk hole or on the point of the center, as this will cause the work to run out of true when the dirt is removed. I have seen valuable pieces of work ruined because of lack of attention to this simple precaution. A man turned a piece to grinding size—.005 inch to .008 inch large; when it was taken to the grinder he cleaned the centers out carefully and removed a chip which had become imbedded in the piece. When turning in the lathe this chip held one side of the countersunk surface from the center, as in Fig. 3, and when this chip was removed the piece ran out so badly that it was not possible to true it, consequently it was of no value.

When countersinking the ends of a piece of stock care should be taken to use a drill of *suitable* size, and not to make the countersinking out of proportion to the size of the piece. It looks unmechanical, to say the least, to see a ⅜ inch reamer having a countersunk hole in the end, of the size shown in Fig. 4; and it *is not* mechanical, as it weakens the reamer, which is very apt to break when in use, or is more liable to crack when being hardened than if it were countersunk the proper depth.

A peculiarity of steel—both machinery and tool steel—is that it is very liable to go out of straight when the surface—skin—is removed. For this reason it is always advisable to rough the piece all over, removing all the exterior surface before finishing any portion to size.

A point I hesitate about mentioning because careful workmen will say that "any boy should know that," is that when starting to machine a piece in the lathe the ends should always be squared to length first, or at least before any portion is turned to size; and all work on the ends that is in any way liable to affect the center should be done before sizing any portion, otherwise the work may be thrown out of true.

Cutting Speeds.

The metals generally worked when making tools are cast iron, machinery steel, and tool steel. A workman who has the welfare of his concern at heart will always use speeds and feeds best adapted to the work he is doing, that he may turn out the maximum amount of work. Generally speaking, it is possible to run at faster speeds and use coarser feeds when machining cast iron than when either machinery steel or tool steel is being cut. The speed which gives best results when machining any form of iron cannot be stated arbitrarily, as very much depends on the condition of the metal being cut, and also on the condition of the cutting tool. Yet it is necessary to know the speeds that give best results under ordinary circumstances. It has been ascertained by experiment that the following rates of speed give good results under ordinary conditions: Cast iron, 40 feet per minute; machinery steel, 30 to 34 feet per minute; tool steel, 20 to 25 feet per minute. If the cut is light and the metal soft, these speeds may be exceeded, but if the cuts are heavy or the metal hard it will be found necessary many times to run much slower.

In order to know how fast to run the machine, for stock of various diameters, the following simple rule is given: Multiply the diameter of the piece in inches by 3.1416 to obtain the circumference, or the distance around the outside of the piece; now reduce the number of feet the piece should be run per minute to inches. That is, if it is cast iron, reduce 40 feet to inches; 40×12=480. Then divide 480 by the circumference of the piece to be turned in inches and the answer will be the number of turns per minute at which the lathe should run. If the workman is not familiar with decimal fractions, he may multiply the diameter of the piece by 3 1/7, instead of 3.1416.

To illustrate the above, suppose we were to turn a piece of machinery steel 3½ inches diameter and desired to know the correct speed to run the lathe, first multiply 3.1416 by 3½ inches and our answer is 10.99. We next reduce 34 feet—the speed we can run machinery steel at—to inches, 34×12 inches = 408 inches; then divide 408 inches by 10.99 and we get as our answer 37 and a fraction. So we know that in order to get good results as to time we must have the lathe run about 37 revolutions per minute. The experienced mechanic can tell by observation when a piece of stock is running at about the right speed, but for the benefit of those whose experience is somewhat limited the above is given.

Reamers.

The principles involved when making tools can best be explained by considering each tool or class of tools separately. We will first consider the reamer.

The reamer is a tool used in making a hole true to size and smooth. The term "reamer," however, is oftentimes applied to a tool used to enlarge a cored hole, or a hole already drilled, without any reference to the size or condition of the hole. Reamers may be arranged in classes, according to shape, as follows: Straight reamers, taper reamers, and formed reamers. They are made solid, adjustable, and with inserted blades, which constitute the cutting teeth.

Solid reamers are made of *one* piece of stock, and are so named because the cutting teeth and head are solid with each other; they are not adjustable as to size. Fig. 5 shows a solid, fluted reamer. Inserted blade reamers are so called because the cutting teeth or blades are made from separate pieces of steel and inserted in slots in the head, as shown in Fig. 6. When making the adjustable form of reamer, we can have the cutting teeth solid with the head, or the reamer may be made with inserted blades, but it must have some means of adjustment as to size.

Fluted Hand Reamers.

The first form of straight reamer we will consider is the fluted hand reamer. This is straight on the cutting portion, except for a short distance at the end, as shown at *A*, Fig. 5, which portion is slightly tapered so that the end of the reamer may enter the hole.

In selecting tool steel for tools whose cutting edges are around the circumference of the piece it is necessary to take stock somewhat larger than finish size in order that the decarbonized portion at the surface may be removed. This surface becomes decarbonized by the oxygen of the air acting on the carbon at or near the surface of the steel when it is red hot, during the various operations in the steel mill and forge shop; and if this portion is not removed it will be found impossible to harden the very parts we wish hard. Knowing this, we select stock 3-32 to ⅛ inch larger than finish size.

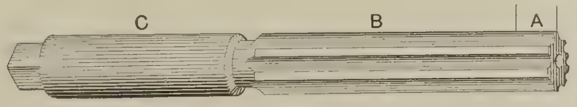
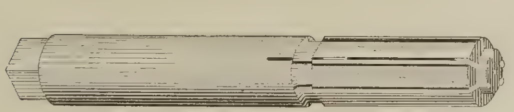


Fig. 5



Industrial Press, N.Y.

Fig. 6

When centering, be sure and have the centers central with the outside of the piece, as shown in Fig. 7, so that an equal amount of the decarbonized portion may be removed all around the piece. Should the piece be centered as shown in Fig. 8 we must necessarily remove all the decarbonized portion on one side and very little on the other, and when the article is hardened it will be found hard on one side and soft on the opposite side; or, if this side is hardened at all it will not be as hard as that opposite, and, moreover, the piece will be very apt to spring from the unequal contraction on the opposite sides of the piece.

Having centered the piece properly, first square the ends to length and clean all burrs and dirt out of the center hole. Turn a chip off the outside surface to a depth of 1-32 inch, then anneal the steel. It is advisable to anneal before turning to size, even though the steel may be soft enough to work well without it, the object being to remove the strains set up in the steel mill by the various operations of rolling and hammering, otherwise these strains may be set up in the forge shop when the piece is forged to shape. When the piece is heated for annealing the tendency to crack or spring when it is hardened is overcome or reduced to the minimum.

The method to be pursued when annealing depends on the facilities afforded in the shop where the work is done. If we have at hand the necessary furnaces and annealing boxes, it is a good plan to pack the steel in charcoal—finely granulated—in an annealing box, place in a furnace and run for a sufficient length of time to have the steel become uniformly heated. The box should be removed from the furnace and allowed to cool slowly. An excellent method consists in placing the steel when red hot in *hot* lime or ashes, burying it well and allowing to cool as slowly as possible. It must not, however, be placed in damp or cold lime or ashes.

If the piece of steel from which we are to make the reamer is comparatively short there will be little liability of its springing by the process of annealing; but if it be long it is very liable to spring from the cause mentioned; that is, from the strains due to uneven heating or cooling, or that may be set up by the operation of rolling or hammering in the steel mill or forging in the forge shop, which manifest themselves as the steel heats. Consequently the steel crooks. Now, if the tool is to be hardened after it is completed the steel must not be straightened when cold. Should it spring enough so it could not be machined without straightening, it must be heated red hot and straightened, as otherwise it is almost sure to spring when it is hardened.

After annealing clean out the center holes with the center reamer, in order that no scale or dirt of any sort be in them, then turn *B* and *C*, Fig. 5, to sizes from .010 to .015 inch larger than finish size, necking down between cutting portion and shank, as shown. It is always advisable to mill the square portion before cutting the flutes. This is usually done by holding the reamer between centers on the milling machine and elevating the knee of the machine, thus feeding the stock to be cut up past the milling cutter, which must, of course, be an end mill. After the cut has been taken and the knee of the machine has been lowered, the index head of the milling machine may be revolved one-quarter turn, which places the reamer in position for the next cut. This must be continued until all four of the square sides are milled. After milling the square portion to size, a suitable dog may be placed on the square end, and the flutes which form the cutting edges may be milled.

Some manufacturers of reamers mill the flutes straight, while others claim best results if the teeth are cut spiral, using what is termed a left-hand spiral in order that the reamer will not have a tendency to draw into the work, as would be the case were the opposite spiral used.

Mechanics generally agree that a reamer with straight teeth gives good results when reaming holes in sound stock, or where there are no grooves or other depressions in the walls of the hole; when these difficulties are encountered then the reamer with the teeth cut spiraling seems to be the most satisfactory.

The Number of Cutting Edges.

As fluted reamers are generally intended for removing but a small amount of stock, and to produce smooth holes of accurate size, it is necessary that certain rules be observed as to the number of teeth they have. It is not generally considered good practice to give such reamers less than six flutes. However, in order that the reader may know the number of teeth generally given, a table of cutting edges for fluted reamers is given.

TABLE I. CUTTING EDGES FOR FLUTED REAMERS.

$\frac{1}{8}$" to $\frac{7}{16}$"	diameter	6 teeth.
$\frac{1}{2}$" to $\frac{11}{16}$"	"	6 to 8 "
$\frac{3}{4}$" to 1"	"	8 "
$1\frac{1}{16}$" to $1\frac{1}{2}$"	"	10 "
$1\frac{9}{16}$" to $2\frac{1}{8}$"	"	12 "
$2\frac{1}{4}$" to 3"	"	14 "

It is necessary when milling reamers having the number of teeth in this table to use milling cutters made especially for the purpose, so as to obtain the correct shape of tooth and a flute that will hold the necessary amount of chips.

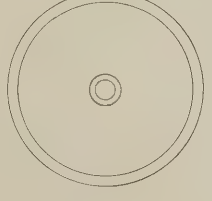
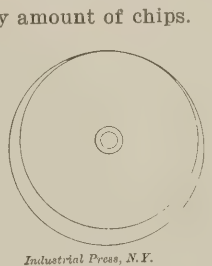


Fig. 7.



Industrial Press, N.Y.

Fig. 8.

A mistake often made in making cutting tools is paying too little attention to the matter of chips. Stock is removed from steel, when machining, in the form of chips, and unless provision is made for these chips they are in the way. They fill the flutes of the tool, get in front of the cutting edges, and are forced into the surface of the work, tearing it and making unsightly work. Then, again, they wedge between the tool and the work, clogging it, and as a consequence the teeth are broken; or perhaps when sufficient force is applied to move it the tool is broken.

Now, to secure a tooth strong enough to stand up to the work without springing, and yet provide a flute that will take care of the chips, special cutters are sold. The herewith table shows the number of the cutter suitable for any size reamer.

TABLE II. NUMBER OF CUTTER FOR REAMERS.

No. 1	cutter	cuts	reamers	from	$\frac{1}{8}$"	to	$\frac{3}{16}$"	diameter
No. 2	"	"	"	"	$\frac{1}{4}$"	to	$\frac{5}{16}$"	"
No 3	"	"	"	"	$\frac{3}{8}$"	to	$\frac{7}{16}$"	"
No. 4	"	"	"	"	$\frac{1}{2}$"	to	$\frac{11}{16}$"	"
No. 5	"	"	"	"	$\frac{3}{4}$"	to	1"	"
No. 6	"	"	"	"	$1\frac{1}{16}$"	to	$1\frac{1}{2}$"	"
No 7	"	"	"	"	$1\frac{9}{16}$"	to	$2\frac{1}{8}$"	"
No. 8	"	"	"	"	$2\frac{1}{4}$"	to	3"	"

It was formerly considered necessary, to avoid chattering, to mill an odd number of flutes in reamers. The writer remembers the first reamer of this style that he was given to make. It was impressed on his mind that it was almost a crime to make a fluted reamer with an even number of teeth. It has, however, been settled beyond the shadow of a doubt that an even number of teeth *unevenly* spaced gives as good results as an odd number. And such reamers are much easier to make, on account of the ease of gaging as to size when grinding. The teeth being opposite each other, can be gaged by a micrometer caliper, while it is necessary to gage those having an uneven number of teeth with a *ring gage* of the correct size, which is not only costly, but the liability of getting the centers out of line, or a particle of emery dust in the center holes while gaging, is very annoying. Should any dust get into the countersunk hole, as mentioned, it will, of course, cause the article to run out of true. In many cases the operator will grind the piece before noticing the trouble, and when a piece of work is nearly to size a very small particle of dirt of any character will cause it to run out enough to spoil it if touched with a revolving emery wheel.

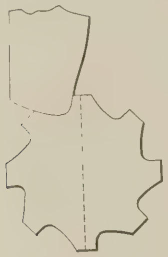
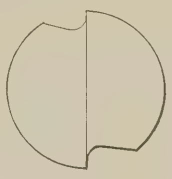


Fig. 9.



Industrial Press, N.Y.

Fig. 10.

Fig. 9 shows a form of cutter made especially for milling the flutes in reamers. The number of the cutter to use for each size of reamer is given in Table II. This form of cutter makes a tooth that is strong enough to cut and not spring, and the flute is of proper size to take care of the chips removed.

The cutter should be set so as to cut the face of the tooth somewhat ahead of the center, as shown in Fig. 9. This is known as a negative rake; the amount should be about 5 degrees. Generally speaking, a reamer will cut smoother if the cutting edge of the tooth has a negative rake—rather than radial—that is, running toward the center, as shown in Fig. 10.

It has been ascertained by experiment that when the form of milling machine cutter shown is used in milling the flutes, the depth of the cut can be accurately determined. It should be of a depth that will make the land one-fifth the average distance from the face of one tooth to that of the next. Should it not be as deep there will not be room in the grooves to hold the chips; should it be deeper, the teeth will not be sufficiently strong, and will spring out into the stock being cut, producing a very unsatisfactory hole which will in all probability be larger than the reamer.

When the piece of work has been milled square on the wrench end, and is ready to have the grooves milled, the cutter is located so as to give the face of the tooth a negative rake, as described. As stated, we can give it an even number of teeth provided they are unevenly spaced, yet in order that the size may be handily calipered when grinding, the teeth must be diametrically opposite each other. The irregularity of spacing must occur between teeth adjoining (next to) each other. To accomplish this we cut one tooth, then turn the index head of the milling machine one-half revolution and cut the opposite tooth.

For the benefit of any who may not be familiar with the working of the index head used on the universal milling machine we will say it is so constructed that it is necessary to give the index pin arm 40 revolutions in order that the work held between the center may make one revolution; of course it is necessary to put the pin in the hole we started from. To turn the reamer one-half way round we would turn the index pin twenty revolutions. Having cut the first pair of flutes—opposite each other—we turn the index head to bring the reamer in position for the next tooth. As previously stated, it is best to cut the teeth so they will be *unevenly* spaced; the irregularity of spacing is obtained by moving the index pin a greater or less number of holes than would produce evenly-spaced teeth. It is generally considered good practice to have a variation of about 3 degrees from an angle corresponding to regular spacing; it is not necessary that it be just 3 degrees—anywhere from 2 degrees to 4 degrees will answer.

In order to produce a variation of a few degrees from even spacing it is necessary to calculate the number of holes necessary to move the index pin for each move, so as to produce an unevenness of spacing that shall vary at least two degrees and not more than four degrees from an amount equal to even spacing; and as an explanation of this would cover more ground than should be taken up in this article we will consider this in our next.

* * *

THE EUCALYPTUS TREE AS AN INEXHAUSTIBLE SOURCE OF FUEL.

In 1882 Mr. Hutchins and Sir A. Brandis, as the result of their experiments, discovered that eucalypts planted on tropical mountains produce fuel at the rate of 20 tons—dry weight at 60 pounds per cubic foot—per acre per year in perpetuity. The eucalypt plantation reproduces itself when cut without further expense, and its dry timber, heavier than coal, has an equal or a higher thermal power, bulk for bulk, than coal. This result was obtained as a measurement of the maximum yield of the Eucalyptus on the Nilgiris, southern India. If a chance tree on a chance mountain in a chance soil can produce the equivalent of 20 tons of coal per acre per year, it seems not unreasonable to suppose, as Mr. Hutchins suggests, that by selection double this, or 40 tons, can be produced. A powerful sun, a heavy rainfall, and a very rapid forced growth are the essentials of such a production of wood fuel. A glance over the rainfall map of the world shows these conditions are fulfilled over about 8,000,000,000 acres of its surface, which is between one-fourth and one-fifth of the total land surface of 35,200,000,000 acres. One half of this area under forest might thus yield the equivalent of 160,000,000,000 tons of coal yearly, which is more than 288 times the world's present consumption of coal, assuming that coal and eucalypt timber are of approximately equal heating power. On the basis of the actual forest yield of the present day, we have half of this, or the equivalent of 80,500,000,000 tons. In Germany, one-fourth of the total area is under forest, and taking the German standard of one-fourth forest, on the basis of the present maximum yield we should obtain 40,250,000,000 tons; while if the maximum forest yield be converted to an average forest yield there would still remain a yearly product of 20,175,000,000 tons, which is rather more than thirty times the world's present consumption of coal. Thus it is seen that the yield of firewood from the world's tropical and extra-tropical forests, wherever they are fully stocked and scientifically worked, will yield the equivalent of from 30 to 122 times the present consumption of coal, or even up to 243 times that consumption, if the present timber yield be doubled by cultivation.—*Journal of the Franklin Institute.*

* * *

Mechanics are familiar with the hand drills, screw drivers, etc., which have a long spindle, spirally threaded, on which is a nut of peculiar construction that can be moved back and forth, to drive the tool at a rapid speed of rotation. Mechanics who are also sportsmen will be interested to know that the device has been applied to the handles of fly rods, for operating the reels. A sleeve slides on the outside of the rod handle and operates the spiral spindle, which is inside, through a slot in the handle. Bevel gears, with ratchet, connect the spindle with the reel. The inventors are Allen E. Hall and William G. Smith, of Philadelphia, Pa.

MACHINE SHOP EQUIPMENT.—4.

EQUIPMENT OF THE PATTERN SHOP AND PATTERN STORAGE ROOM.

OSCAR E. PERRIGO.

Next to the drawing room in the usual order of the production of new machines, and the development of new plans and ideas into their practical form for commercial purposes, comes the pattern shop, with its proper equipment of woodworking machines, its work benches for the expert workmen, and the conveniences for those associated with them in getting out dimension lumber, and other similar work in connection with it; and closely allied with this department, and really forming a part of it, the pattern storage room, wherein patterns may be properly catalogued, stored and issued to the foundry as occasion may require.

In the pattern shop proper the designs of the draftsmen are first brought into tangible form, as patterns for the production of those parts to be made of that most common of all materials used in modern construction, namely, cast iron, as well as those for brass, malleable iron and steel castings.

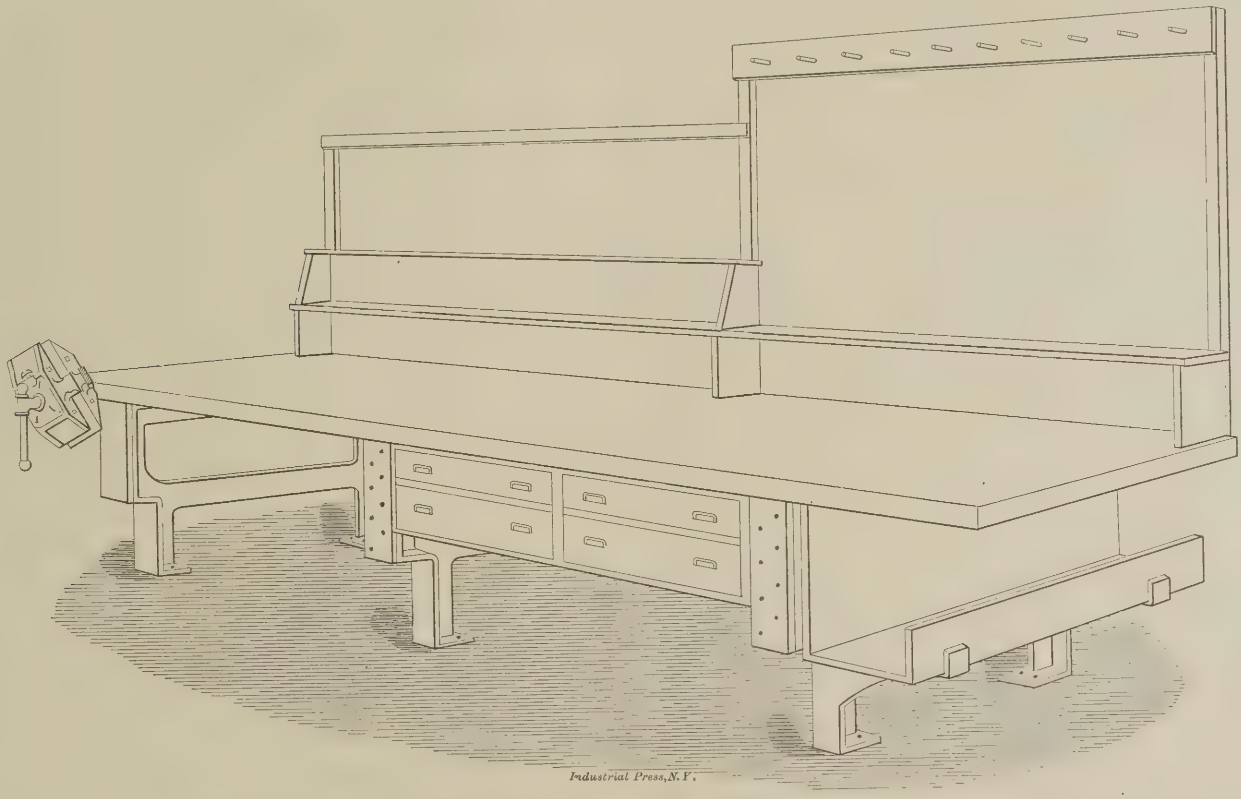

Industrial Press, N. Y.

Fig. 1. Patternmakers' Bench.

It is proper, therefore, as well as convenient, that the pattern shop should be placed next to the drawing room. In this case it opens out of it, and has also its convenient passageway to the machine shop by way of a wide door opening upon the machine shop gallery, which, being reached by the large traveling crane, affords a ready means for moving any heavy or bulky articles to and from the pattern shop as readily as to any part of the machine shop.

The pattern shop occupies the space over the tool room and store room portions of one of the fifty foot square structures, and extends, also, over the space taken up by the main driveway on the ground floor. It is thus fifty by seventy feet, affording ample space for all the ordinary uses of this department.

In Fig. 2 is shown the plan of the pattern shop and the pattern storage room, and the location of the tools, machines, benches and other fixtures therein, as well as those in the pattern storage room, giving the location of the pattern storage racks, and the trap doors, one of which opens over the storage space in the yard and the other over the flask room of the foundry.

As to the capacity of the pattern shop and the number of workmen who may be employed in it to advantage, assuming that the arrangement is in force of having special men for special work, there may be fourteen men as its regular force. These will be divided as follows, namely, one foreman, six regular pattern makers, one man at the lathes, one man at the planers, one man for the rip saw and the cutting-off saw, one man at the band saw and for building up segment work, one man at the varnish bench for varnishing patterns, and one man to letter and keep a record of patterns, and one general laborer.

If the product of the shop is in a regular line where nearly the same work is turned out year after year, we have only to provide for the necessary changes of patterns due to the usual changes of form and style that may be required by the demands of trade. In this case the force above provided for could well be considerably reduced. If the product of the establishment is of such a nature that improvements, both in the work turned out and also in the tools necessary to accomplish that result are constantly in progress, the force above specified will not be too great. If the product is such that a majority of the orders are for such machines as have to be made special, or with important features specialized to meet individual cases, then the force described above may not be sufficient to maintain an evenly balanced arrangement and division of the working force of the establishment.

Where the latter condition is found it may be necessary to use a portion of the pattern storage room adjoining the pattern shop, and well lighted for such use, should it become necessary.

The equipment of the pattern shop has been carefully worked out, with the end constantly in view of so arranging the available space and of so equipping it with such woodworking machinery as may be necessary to carry out the plan of keeping the skilled pattern makers constantly at work on that which is essentially pattern work, and requiring a man skilled in that vocation, rather than of allowing them to use their time in getting out dimension lumber, varnishing patterns, and similar work, which may be just as well done by men of less ability and a lower rate of wages.

Consequently the machines, such as surface planer, jointer, rip saw, cutting-off saw, etc., are handled by men who are practically "mill men" who, while they know little or nothing about pattern making, are capable of getting out such dimen-

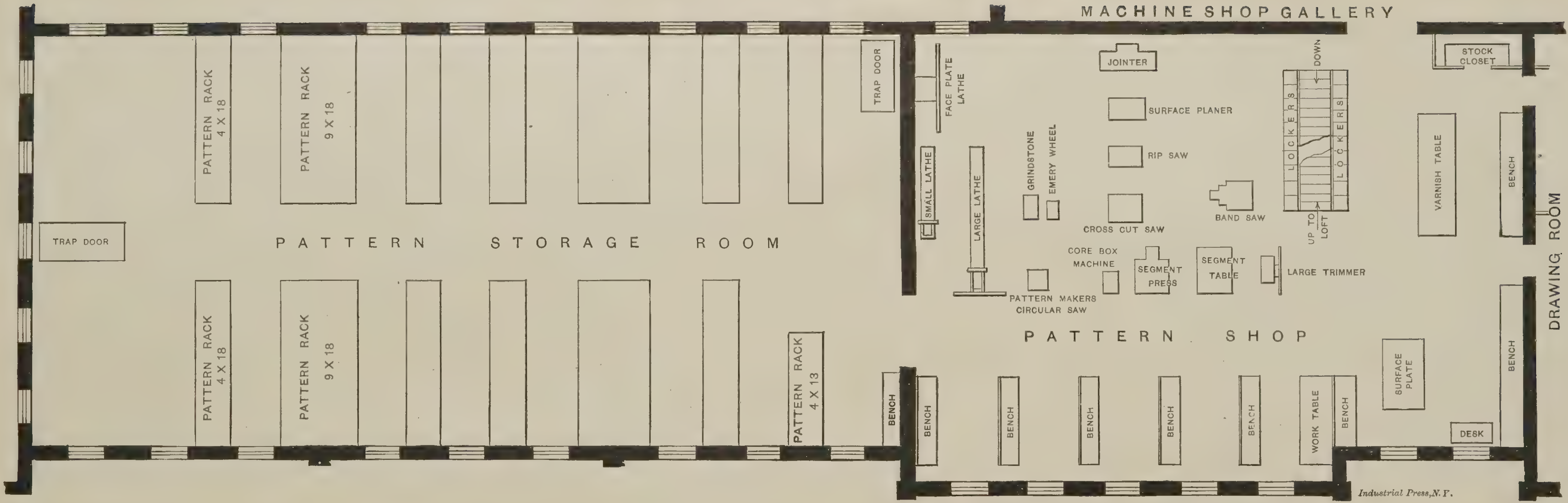


Fig. 2. Plan of Pattern Shop and Pattern Storage Room.

sion lumber as may be called for by the pattern makers in much less time and at less cost than if it were done by the pattern maker himself. So it is with the man who handles the band saw, whose principal work is that of cutting out segments for the building up of the rims of wheels, gears, etc. Being constantly at this particular kind of work, the man need not be a skilled pattern maker and yet can exceed one in the output and the economy of doing this class of work. In the same manner for varnishing of new patterns and the revarnishing of old ones, a pattern maker is not needed. Neither is it necessary to employ one to mark, letter, arrange and catalogue the patterns when completed, as this work may be just as well and much more economically done by a special man at a less rate of wages.

The equipment of machinery and fixtures for the pattern shop, and the location selected for them to insure convenience of their operation and of the handling of stock and product without unnecessary labor, is fully shown in the general plan in Fig. 2, and is as follows: Next to the machine shop wall is placed a jointing planer, provided with the usual guides and gages by which the various angles or bevels may be cut upon any length of stock up to sixteen feet. Beside this is an ordinary surfacing planer capable of taking in twenty-four inches in width and, also, sixteen feet in length. Upon the jointing planer stuff may be planed "out-of-wind," and then passed to the surfacing planer for reducing it to an even thickness. If much large work is to be made where large and perfectly true surfaces are necessary to be obtained, it will be advisable to have a Daniels, or vertical planer, to which this stuff is first taken. From the surface planer the stuff passes to the rip saw, and from there to the cutting-off or cross-cut saw. In many cases it must be passed back to the jointer to be finished on the edges.

Shop trucks with proper racks should be provided, upon which the lumber may be placed, so that unnecessary handling or carrying may be avoided.

Next to the segment press is a core-box machine, which is a very convenient, if not almost indispensable, machine where many boxes for round cores are to be made, as it accomplishes the work in a fraction of the time required to do it by hand.

Next to the core-box machine is a special pattern maker's circular saw bench, which is so arranged as to carry both rip saw and cutting-off saw, either of which may be brought into use as needed; and a table capable of being set at any desirable angle. The table is provided with guides and gages for cutting any angle wanted. This saw is of special value in pattern-shop work, and saves much hand labor, even in cutting out the quite small parts of patterns. The Colburn universal saw table is an excellent example of this class of machine.

As a large part of pattern making often consists in laying up segment work, special provision is made for it. From the planers the stuff is taken to the segment table, laid out, then to the band saw where it is cut into segments, from whence it goes to the trimmer, the ends are cut and the segments are fitted into circles on a wooden faceplate. This plate has formed on its under side a recess which fits over the iron faceplate of the lathe. A circle of these segments having been fitted together, they are glued at the ends and small steel dogs inserted to hold them. Another circle is formed and glued at the ends and to the first segment, the dogs being placed in the edges, out of the way, and the whole placed in the segment press, which holds it firmly until the glue has set; and so on until the job has been completely laid up. It is convenient to have two faceplates to work on alternately, as one may be in the press while an additional circle of segments is being fitted to the other. The segment press is of the vertical type, and may be constructed with a large screw acting upon a follower, or it may be built similar to a Greenerd arbor press with a rack and pinion arrangement. A convenient form is one with a vertical screw having fixed to its upper end a large wormwheel which engages a worm upon a horizontal shaft, which extends to one side of the press, where a handwheel is attached to it for convenience of operating. With this arrangement segments may be made and laid up in much less time than where hand clamps are used and applied as each segment is laid on, while the evenly distributed pressure insures good contact of all the pieces. They may be nailed, or not, as desired.

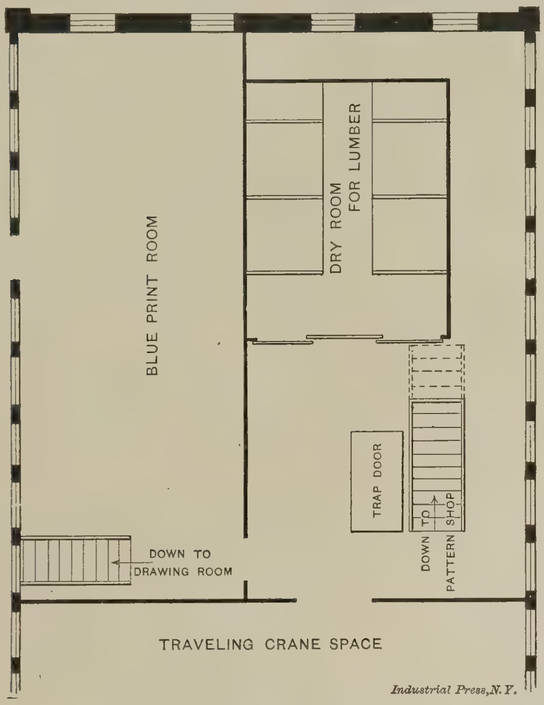


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Fig 3. Plan of Loft over Pattern Shop.

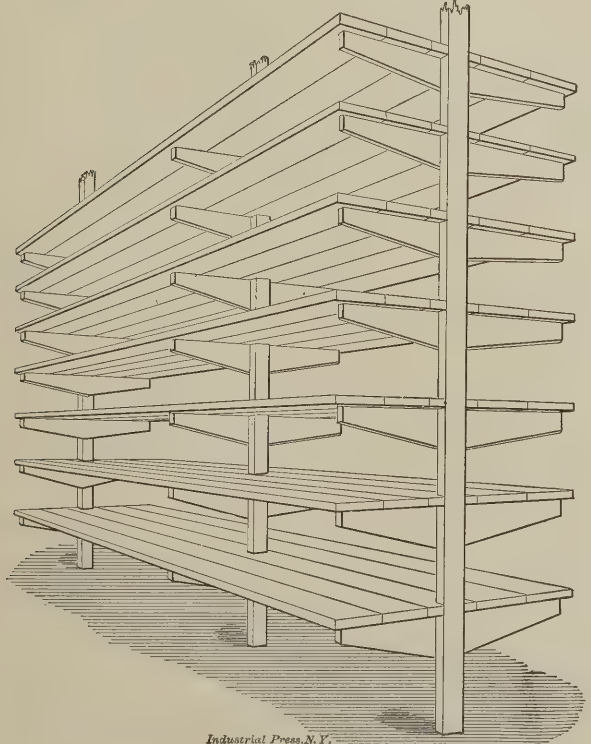
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Fig. 4. Pattern Rack.

For small turned work a wood lathe to swing eighteen inches, and with a ten-foot bed, is provided. For larger work a lathe of thirty inches swing and with a sixteen-foot bed will be a good size. Both should be provided with slide rests, and the larger one with a faceplate on the back end of the spindle for turning large work from a floor rest. When much larger faceplate work is called for, a faceplate head is needed, and one is located near the rear wall and in line with a rear window. This head carries a faceplate capable of swinging ten feet. In front of this, may be arranged a compound rest, supported by a pedestal, and capable of covering the turning, inside and out, and of facing the largest work to be done.

Near the lathes the grindstone and the emery wheel are located. The latter should be provided with wheels of different form for grinding the various shapes and sizes of gouges and similar tools in use.

The foreman's corner is next to the drawing room, so as to be in convenient communication with that department. He has a bench, more as an occasional convenience than for regular use, and a desk, as a necessary part of his equipment.

The first pattern maker from him has, in addition to the regular equipment, the use of a cast-iron surface plate, say five by eight feet, its dimensions regulated, of course, by the kind of work to be done. This is an indispensable convenience in building up many of the more complicated patterns, and there should be at least one in every pattern shop.

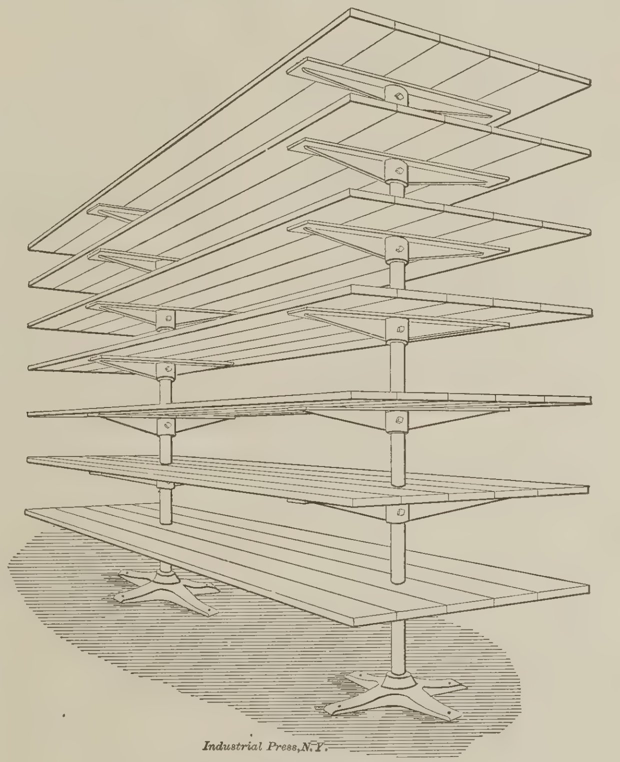
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Fig. 5. Pattern Rack with Metal Frame.

The pattern maker's bench is shown in perspective in Fig. 1. The top is thirty inches wide and ten feet long. It stands thirty-four inches high. It is composed of hard maple at the front, twelve inches wide, and the rear portion of white pine, both two and a half inches thick. It is supported on three cast-iron bench legs, the front feet of which are set back five or six inches, so as to be out of the way of the pattern maker's feet. The upper sixteen inches of these legs has a facing of hard maple, that on the center and rear legs having holes for the introduction of pins for supporting long work when held on edge. Four drawers, with flush pulls, are placed in a case under the rear portion of the bench, for holding small tools, files and a variety of similar articles found necessary by every pattern maker. At the rear end is formed a compartment under the bench for holding short pieces of hardwood stock, dowel pins and similar materials. At the head of the bench is located an Emmert universal vise, which seems to be the best device yet put on the market for this purpose, as it may be placed in almost any position convenient to the workman, and will hold a piece of almost any form with equal facility. At the back of the bench is a shelf or tool rack extending the whole length, and at a proper height above it is one extending one half the length. These are to be properly perforated for the reception of the ordinary tools of the pattern maker, such as his chisels, gouges, auger bits, twist bits and drills, screw drivers, and all similar tools. Over this short tool rack the backboard is extended up to a light rail, so as to provide a space for hanging larger tools, such as bit-stocks, back saws, and tools of this nature. At the back of the rear half is an open frame whose top bar is provided with pins for hanging large saws and similar articles. If the kind of work renders it necessary a bench trimmer should be attached at the rear end. This style of a bench is at once rigid and substantial, does not occupy unnecessary floor space, is compact and complete in all its arrangements, and for a first-class bench it is economical in cost.

These benches are arranged with the head toward the wall and two feet from it, so that private tool boxes or cupboards may be conveniently arranged upon it. Their positions are clearly shown in the plan.

A large work table is provided for the second pattern maker, and one should be provided for the others when the nature of their work requires it. It may be placed either between the benches, or near their rear end, as may be most convenient.

It will be noticed that the benches and machines are so arranged that they leave a broad alley through the shop, and to the door leading to the machine shop gallery.

There is a regular wall bench and a large center table provided for the varnisher and the workman having charge of the marking, numbering and cataloguing of the patterns. From this point they may be taken on properly-arranged platform trucks, to the pattern storage room, or to the foundry, as the case may require.

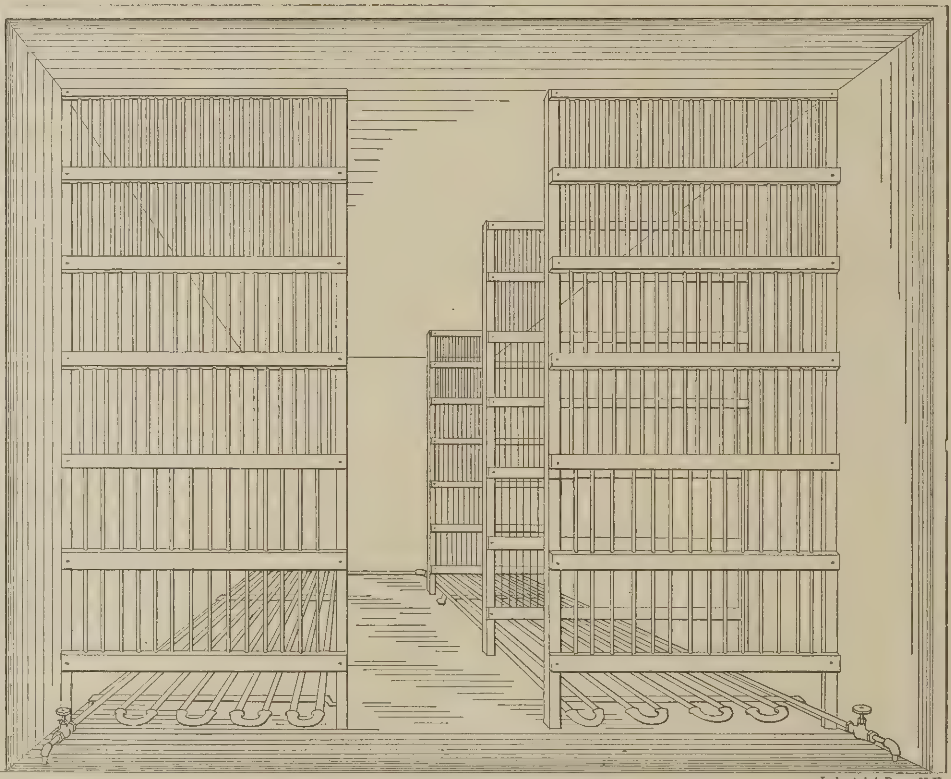
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Fig. 6. Dry Room for Lumber.

At each side of the stairs leading to the loft the individual lockers for the use of the men are arranged. These are of the expanded metal type, as built by Merritt & Co., or of some very similar material and construction, but never of boards, or any construction which excludes thorough ventilation and safety from fire.

The stairs just mentioned lead to the loft shown in the plan in Fig. 3 and in which is constructed a lumber drying room, as laid out in the plan and shown in interior perspective in Fig. 6. This room is tightly closed by double sheathing on the top, the back and both sides. The front is closed by three sliding doors, arranged to pass each other, so that any portion of the front may be opened for the purpose of putting in or taking out lumber. The lumber racks are of wood construction, the posts being 4 x 5 inches, the two lower horizontal timbers 3 x 6 inches; the next two are 3 x 5 inches, and the upper three are 3 x 4 inches. These timbers should be firmly bolted together and to the sides of the room by through and through bolts as there will necessarily be much shrinking of the timbers, and consequently no nails should be used. The sheathing may be put on vertically or horizontally, as preferred, but both thicknesses should run the same direction, and should break joints. The studding or timber work supporting the sheathing should not be over three feet apart, in the direction of the length of the sheathing.

In the drawing, Fig. 6, only the front frame is shown on the left of the room, to avoid a confusion of lines, as the form and location is fully shown on the opposite side. The frames should be placed seven feet apart, so as to accommodate lumber from eight to eighteen feet in length. The lumber is placed on edge, supported by three racks, or frames of this kind and held in place by round iron rods, five-eighths inch for the three lower sections, and one-half inch for the three upper sections. These rods should be placed five inches apart in the lower section, four inches in the second, three and one-quarter inches in the third, two and one-quarter inches in the fourth, one and three-quarter inches in the fifth, and one inch in the sixth, from center to center. The distance apart, in the clear, for the horizontal supports, should be eighteen inches for the lower four spaces, and sixteen inches for the upper two spaces, if lumber of the ordinary widths is to be used.

Heat may be applied by a steam coil as shown in Fig. 6, or hot air may be admitted from the regular air pipes of the heating system. The degree of heat should not be high as the seasoning process is apt to be too much hurried and so produce an unnecessary number of "season checks" by drying and consequently shrinking the outer portion of the lumber before the center has the opportunity to contract with it. Some have advocated the plan of standing the lumber on end, and then turning it "end for end" once a week. This causes an unnecessary amount of labor. If the lumber is placed in the racks as shown, it will not be necessary to even turn it over, provided too high a temperature is not maintained. The necessity for a dry room is apparent from the fact that it is very difficult to obtain properly kiln-dried lumber fit to put into pattern work, whatever price we are willing to pay for it. And unless we dry it ourselves we are never sure of its condition. Patterns are too expensive to take any chances of improperly seasoned lumber.

For convenience in passing lumber to and from the dry room, a trap door, as shown in Fig. 3, may be made in the floor of the loft. Pattern lumber may be delivered on the machine shop floor, passed to the gallery by the traveling crane, then up through this trap door to the dry room. After it is properly dried, it may be passed back to the pattern shop in the same way. Or, it may be passed in through the trap door over the pig iron storage space, and thence into the pattern shop.

The pattern storage room is a continuation of the pattern shop, a door eight feet wide giving ample access to it. In the inner corner, next to the pattern shop, is a trap door four feet by eight, opening over the pig iron storage space, and at the other end of the room is a trap door four by ten feet, opening over the flask room of the foundry. Over this trap door is a quick-acting hoist by which patterns may be readily lowered to the foundry, or brought back to the pattern storage room. This room is amply lighted so that patterns may be easily found, stored, or taken from the shelves as needed.

The system of storing patterns is upon a series of shelves arranged so as to form alcoves connecting with a wide passage way in the center, the pattern racks being placed with the end against the wall, and regularly between the windows. Opposite the broad spaces in the walls where the pilasters are located, and space between windows is wider, the pattern racks are made of double width, and are used for the storage of larger patterns, which may be more conveniently stored on very broad shelves. Should the patterns be generally of small size, so as to make narrower shelves advisable, the racks may be all made of single width and located without regard to the windows. In this case they are placed two feet from the wall. In the arrangement shown, the single racks have shelves four by eighteen feet, and in the double racks the shelves are nine by eighteen feet. Thus, the latter style will accommodate from four to nine feet in length.

At the end of the pattern storage room next to the foundry, a space is left clear for the care and storage of patterns too large for placing upon the shelves. It will, of course, be understood that in every shop special arrangements must be made for the care of patterns peculiar to the kind of work done, and that the arrangement here given is only such as may be useful in a general way, and that it is subject to whatever modification may be necessary to suit individual conditions. For instance, if there are many heavy patterns like lathe beds, planer beds, or engine beds, etc., it will be necessary to provide a larger space for them, and also, to arrange for readily lifting and moving them. A convenient method is to suspend an I-beam overhead, and upon this to run a trolley with a chain or rope hoist, by means of which the patterns can be picked up and moved wherever they are wanted. These may be put up with branches and switches, so as to cover any desired space. If these large patterns are placed entirely upon the floor they will occupy too much valuable space. They may be arranged in this manner: One bed pattern may lie upon strips not less than an inch thick laid on the floor. Over this pattern are placed two or more trestles, high enough to clear it. Upon these a second pattern may be placed. Over this place still higher trestles, and upon them support a third pattern, and so on. The advantage of this method is that the patterns may be always kept in good condition and "out-of-wind," while if, as is often done, strips are laid upon one pattern, and another pattern supported upon it, there is a strong probability that it will be marred and injured, or warped out of shape.

Various forms of racks, both self-supporting and attached to the building, have been devised. The common form used to be that of supporting the shelves by a series of posts placed four to eight feet apart, and spiking to these horizontal strips, upon which the boards or planks forming the shelves were placed. Frequently a strip three or four inches high was placed around the shelves to prevent the patterns from falling off. This made a receptacle for dust and dirt which was not only disagreeable but difficult to get rid of. In this form of racks the numerous uprights obscured a good deal of light, and were very much in the way of conveniently handling patterns.

Considering these conditions, the best arrangement of pattern racks seems to be of the forms shown in Fig. 4 and Fig. 5. The form shown in Fig. 5 is composed of two heavy cast-iron bases, into which are screwed pieces of three-inch wrought iron pipe. Upon these are fitted cross supports of cast iron with rough-cored holes. They are held at any desired height by two setscrews in each support. Upon these supports the shelves are built, their thickness being according to the weights of patterns to be stored. For ordinary patterns the shelves should be of one and a quarter inch planks, and the distance between supports not over eight feet. Where heavy patterns are to be placed on the shelves the planks should be one and a half inches thick, and the distance between supports reduced to about six feet. In this case setscrews should not be depended upon to hold the cross supports in place. Pieces of wrought iron pipe, large enough to easily slip over the upright supporting pipes, and cut the exact length necessary, should be used, by first placing one over the pipe and resting on the cast-iron base. Then put on the cross support, then another piece of pipe, and so on to the top. The planks are fastened with heavy wood screws passing up through the cross supports. The bases should be fastened to the floor with lag screws.

If inconvenient to construct these tracks with iron supports as just described, they may be constructed entirely of wood. If this is to be done the uprights are fastened to the floor and also to the overhead timbers by nailing, or still better, by iron knees and wood screws, so as to be held firmly in their proper position, as shown in Fig. 4. To these uprights are spiked cross pieces or supports of the form shown, and upon these are laid plank shelves as described for the shelves when iron supports are used. If the patterns are very heavy, the cross supports may be let into recesses in the uprights, and fastened with through and through bolts. The proper distance between supports will be the same as with the iron construction of supports. For ordinary and usual conditions the vertical distances will be about as follows: From the floor to the top of the first shelf, two feet; from the top of the first shelf to the top of the second, twenty-two inches; to the next, eighteen inches; to the next, sixteen inches; to the next, fourteen inches; and to the top, twelve inches. Of course these shelves may be continued higher up than this, but on account of the difficulty of access the above arrangement would seem to be quite high enough.

Several light step ladders should be provided for conveniently reaching the patterns on the upper shelves. Obviously, the heavier patterns will be placed on the lower shelves. Large gears, pulleys, balance wheels, etc., may be set on edge, in racks similar to those used for holding rolls of belting, but are somewhat more liable to become warped than if they are laid down flat on the shelves that are true and level.

In the case of the double width shelves, as called for in the plan, Fig. 2, there should be two upright pieces of wrought iron pipe to carry the cross supports, the latter being made of appropriate form, and having cored in it two holes, four feet apart, from center to center. A similar modification should be made in the wooden construction. For racks of eighteen feet in length there should be three supports, the outer ones placed thirty inches from the ends, and the third one in the center. This will provide for three wrought iron pipe supports in a rack four feet by eighteen feet, and for six supports to a rack that is nine feet by eighteen feet.

One of the greatest conveniences of this system of shelves for storing patterns, is the fact that they are free of access on all sides, with absolutely no obstruction whatever, either to light or the handling of patterns, while their appearance is much better than any of the older forms.

* * *

Some British economists have deplored the exportation of coal from the British Isles, claiming that in so doing they are living on their capital, inasmuch as coal *in situ* is regarded by them as capital. In an editorial on fiscal fallacies the *Colliery Guardian* says that if coal *in situ* is regarded as capital, it is destroyed equally as much if burned at home as though it was exported. If burned at home and the resulting product is exported, the result is exactly the same so far as future generations and the coal supply are concerned, as though the coal had been exported. It is, however, regarded as a fallacy by the *Colliery Guardian* to hold that coal *in situ* is capital; "it can only become capital by utilizing it." Another writer quoted says that "to sit on the lid of our grimy treasure chest until some Edison of the future has rendered its contents valueless, would be a foolish proceeding." From which we infer that while "you cannot eat your cake and have it too," by eating it, ways and means are made by which two cakes can be obtained for the next meal. Miserly saving does not create wealth, it only conserves it; consumption that stimulates a healthy supply does create commerce, wealth, inventions, manufactures and the other attendants of advanced civilization.

* * *

In the description of the new Springfield army rifle, published in the October issue, it was stated that the height of the maximum ordinate of the trajectory shooting at a range of 1,000 yards, is only 20.67 *inches*—a most wonderful result! This should obviously be corrected to read 20.67 feet, which makes it agree with the figures given in the table. The mistake could not have deceived anyone acquainted with the elements of gunnery and the laws of mechanics, but it is an example of the provoking errors that will creep into printed descriptive matter in spite of the most careful scrutiny. The range for a trajectory 20.67 inches high, shooting with this rifle, is about 1,000 feet.

BREECH MECHANISM OF THE 16-INCH COAST DEFENSE GUN.

Much interest, naturally, has been taken by the public in the great 16-inch seacoast defense gun, model 1895, which was recently completed at Watervliet Arsenal after a period of nearly nine years had elapsed since the contract for the great lathe and other machinery was made with the Pond Machine Tool Co. in 1894. Since the completion of the gun it has been transported to Sandy Hook Proving Ground, and has successfully passed the test to which all ordnance is subjected before being permanently mounted.

The 16-inch gun is the most powerful ever built, its 2,370-pound projectile with the normal powder charge (640 pounds of smokeless nitro-cellulose), velocity 2,300 feet per second, having a muzzle striking energy of over 88,000 foot-tons, but there are some doubts as to its practical utility in actual warfare. Nevertheless it is a triumph of design and mechanical construction; so far it is the largest gun built by the modern system of shrinking jackets and hoops upon a tube, giving the latter an initial compression nearly equal to its elastic limit. By this construction the initial compression must be overcome before there is any tendency to burst the tube. Partial details of construction, principal dimensions and other data may be found in MACHINERY for September, 1901, and May, 1902. The following matter has reference to the breech action which is presented as an interesting example of mechanism—not new, of course, but of interest to many readers nevertheless.

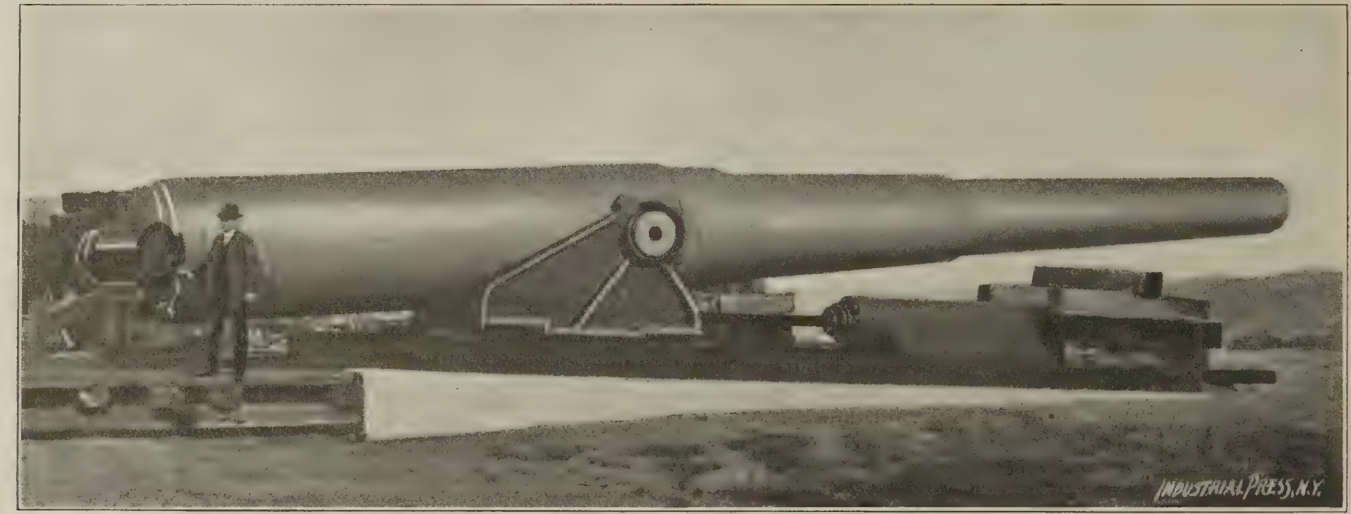


Fig. 1. Sixteen-inch Coast Defense Gun, at the Sandy Hook Proving Ground.

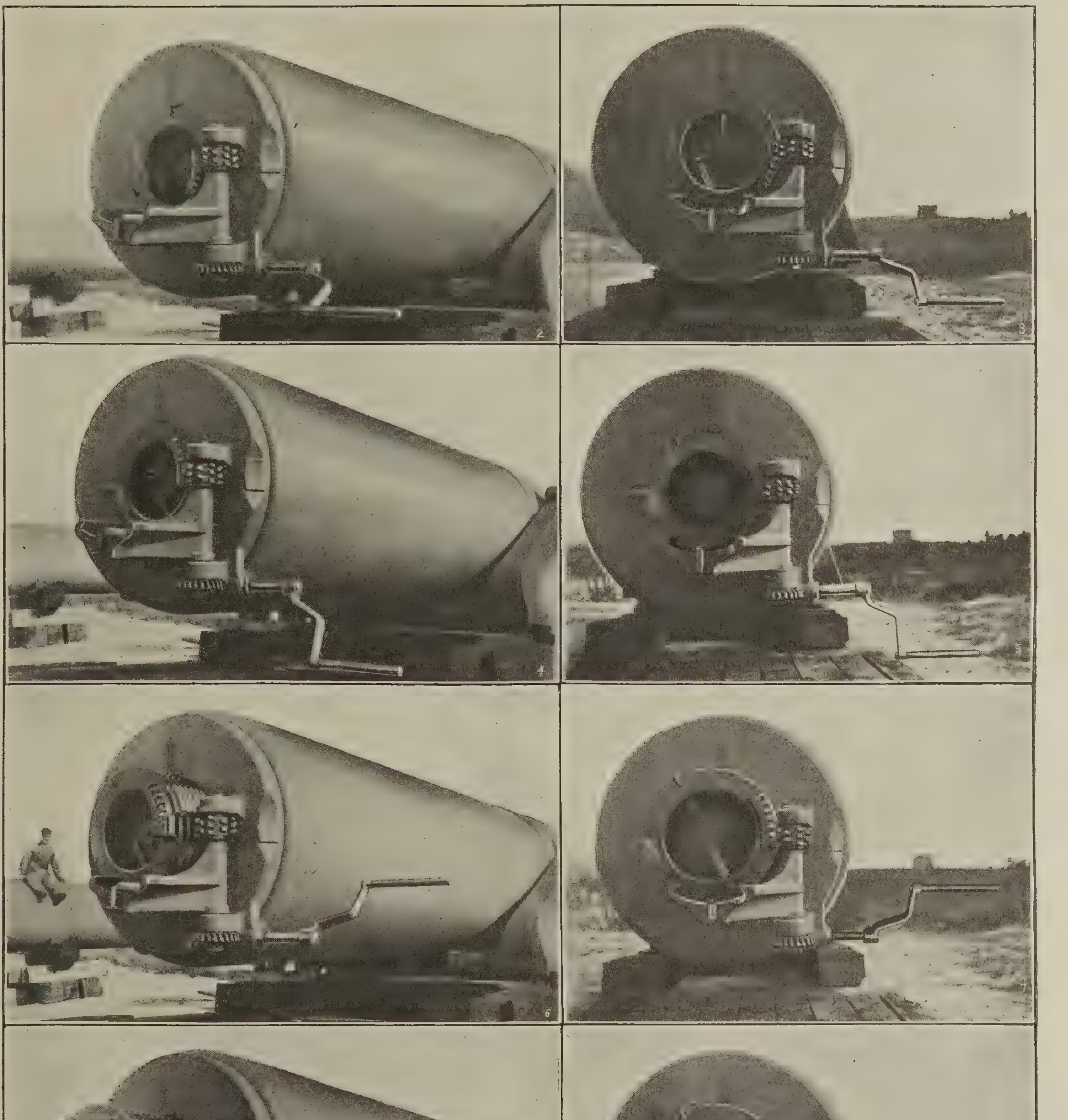
Fig. 1 shows the gun as it now appears on the temporary mounting where the proving charges were fired. The permanent mounting will be on Romer Shoal, a chain of rocks lying between Sandy Hook and the western end of Long Island. Just beyond it is the Gathmann 18-inch gun, which, however, is not nearly so heavy, and some distance beyond that is the Brown wire-wound gun which in a recent test fired a shot with an initial velocity of 2,500 feet per second. A government railway runs the length of the "Hook," and the temporary mountings are all located close to it. Further along the track towards the point of the "Hook" is the regular proving ground where the standard types of seacoast guns and mortars are proved.

The breech actuating mechanism of the 16-inch gun is known as the Stockett system, which does not differ greatly from the Farcot-Fletcher system used on the 10 and 12-inch guns, being a modification of same. It is an example of a simple mechanism which performs a somewhat complicated action by simply turning one crank. The views, Figs. 2 to 11 inclusive, show it in the closed and open positions, and in three intermediate positions. Two views are shown in each case, one from the rear and the other at an angle of about 45 degrees.

As stated, only one crank is used to open and close the breech. The action is continuous and entirely automatic in the matter of changing from one motion of the breech-block to another, there being three distinct movements of the block in all.

With the breech closed, turning the crank to the right first rotates the breech-block 30 degrees, or one-twelfth of a turn. This movement disengages the threads of the interrupted screw, there being six sectors threaded and six blank, each 30 degrees wide. To be exact, the width of the threaded sectors in the block is 0.05 inch less than 30 degrees of the total circumference, in order to give the necessary clearance. This completes one movement. Continued turning of the crank is now converted from rotation of the breech-block into translation of same longitudinally from the breech, the interrupted thread now being so disposed as to permit this movement. It will be noticed that the worm, engaging the section of worm-wheel cut from the solid on the end of the breech-block, is also a pinion, having both longitudinal and spiral cuts. It is thus enabled to act in a double capacity—as a worm when rotating the breech-block, and as a pinion when moving it longitudinally. When the breech-block has been rotated 30 degrees, further rotation is prevented by the compound gear coming into contact with that portion of the mutilated worm-wheel or rotating rack in which no tooth space is cut, but it is now opposite the translating rack cut from the solid in its side, and of the slide way prepared for it in the tray. The last tooth of the rotating rack is cut away on the inner side to avoid interference, and the first two teeth of the translating rack are modified also. The moment the breech-block stops turning, the end-thrust upon the rotating rack initiates the longitudinal movement and brings the translating rack into action. The change from one movement to the other is accomplished without perceptible shock or jar, as the writer witnessed. The mechanism is easily operated in either direction from start to finish with one hand.

The motion of translation now begins, which is movement number two. It ejects the breech-block upon the tray, or console, which is grooved with overhanging ledges for the reception of a corresponding section planed in the block. When the block has reached the end of its prescribed travel, the ledges on the tray bring up against stops on the block, and at the same time a latch is tripped which locks the tray to the end of the breech. This latch, the end of which is shown in the middle of the end of the tray, is pivoted near its center so that when the breech-block stop abuts against the upward projecting outer end, the inner hooked end is thrown upward and disengaged from the breech hook or catch. The tray and breech-block are now free to swing on the hinge pin, and are forced to do so, through an angle of about 123 degrees. This completes movement number three and leaves the breech wide open, 22½ turns of the crank having been made. The same number of turns are required, of course, for closing the breech after loading. The hinge pin and the vertical worm shaft are one, and as the worm shaft is mounted on hardened



Figs. 2 to 11 inclusive, showing five Successive Positions of Breech-block of 16-inch Gun at Sandy Hook.

ball bearings, the frictional resistance of operating the first two movements of the block and of swinging it around on the tray, are reduced to a minimum. This partially accounts for the remarkably free and easy movement, but careful fitting is shown in every detail and this is what counts on such work.

The fermeture is of the De Bange or French type. The breech block has an outside diameter of 25.96 inches; total length 27.3 inches; diameter at root of the thread of 24.82 inches; length of threaded portion 19.89 inches. The thread is of symmetrical section, having an inclined angle of 106° 24′ and a pitch of 1.71 inches. The top and bottom of the thread are rounded, the radius of the top being 0.17 inch, and of the bottom 0.11 inch. The shape of the thread differs from that of the naval guns, which is a modified buttress section, making an angle of 15 degrees on one side with the normal to the axis, and 45 degrees with the other. The circular pitch of the wormwheel or rotating rack cut in the block, is 1.577 inch; normal pitch, 1.5 inch. The translating rack has a pitch of 2.426 inches and the depth of the teeth is 1.11 inch. The compound gear operating the block has an outside diameter of 8.685 inches and is quintuple threaded, the threads having a lead of 7.885 inches and an angle of 18 degrees. The pinion teeth for translating the block, are ten in number, circular pitch 2.426 inches, of course, to agree with the pitch of the rack.

The obturator, which appears as the rounded inner end of the breech-block in Figs. 10 and 11, is the De Bange modified type. It consists of a mushroom head having a diameter of 18.85 inches, and a spindle 6.22 inches diameter at the forward part and 5.97 inches at the rear, which passes through the block and is secured by nuts on the outer end. Between the mushroom head and the end of the block packing is interposed to act as a gas-check. When the charge is fired the pressure on the mushroom head forces the packing outward against the walls of the powder chamber and prevents the escape of the gases. To prevent sticking of the action after a discharge, the obturator spindle is made to turn freely in the block so that it may remain stationary when the latter is first being opened. But the backward motion of the block, due to the pitch of its thread, releases the pressure on the packing and loosens it so that it moves freely by the time the block is turned 30 degrees. It is obvious that if the obturator had to turn with the block a heavy twisting moment might have to be applied under some circumstances to start the action loose.

The screw heads shown on the obturator head are for holding the crusher gages which are used when proving the gun, to indicate the pressure developed in the breech chamber by the powder charge. A crusher gage consists of a short steel cylinder inclosing a cavity in which is a copper shell. A hole is bored in the cylinder and in it is fitted a small piston to receive the pressure and transmit it against the copper shell. The latter yields when the charge is fired, and the amount of the yielding or crushing is an index of the pressure.

The firing of a charge is done electrically. The primer is screwed into the small hole in the outer end of the obturator spindle, which may be seen in some of the views. This hole is 0.2 inch diameter and is drilled clear through the spindle and obturator head, terminating in the powder chamber. Circuit breakers are provided so that a charge cannot be fired unless the breech is fairly closed. These may be seen, say, in Fig. 3, one being on the upper side of the breech-block and the other in contact with it and attached to the breech plate. If the breech-block is turned ever so little from the closed position, the contacts are separated and firing cannot be effected. An additional safeguard is a safety lever which is swung over in such a position that a primer cannot be screwed into the primer hole except when the breech is closed. Figs. 3, 5, 7 and 9 show this action.

Some confusion has arisen regarding the weight of this gun, partially, perhaps, because of the practice of the Ordnance Department of expressing weights in long tons. The weight engraved on the muzzle is 284,500 pounds, equivalent to 131 long tons. The 88,000 foot-tons striking energy is in long tons also; in short tons it would be 98,500 foot-tons.

The photographs from which the cuts in the preceding description were made were taken by the associate editors of this journal, acting under permission of the Chief of Ordnance, Washington, D. C., and the commanding officer of the Sandy Hook Proving Ground. The trip from New York City was made one clear day in October last, leaving Pier 12, East River, at 10 A. M. on the Government tug the *Edna V. Crew.* No one not connected with the Government service or not having a pass is permitted to take passage on this tug, nor to land at the Sandy Hook pier. A distance of nearly twenty miles is traversed across the Upper Bay, through the Narrows, and down the Lower Bay before reaching the destination. The route is the same as that traversed by all the larger vessels entering or leaving the port and is one that gives a good idea of the immensity of New York's harbor, and of the commerce that daily plies its waters.

As the name denotes, the "Hook" is a great sand bar curving into the ocean and marking the outer limit of the Lower Bay. It is a barren, desolate spot covered with a scrubby growth of trees and bushes, undisturbed save where the Government fortifications and buildings are located. The latter are mostly wood, but are being replaced with substantial brick structures that will be a credit to the country, which cannot be said of some of the wooden ones now in use. The fortifications are of great extent and appear practically impregnable. They have been greatly improved within the past two years, and the plans are by no means yet complete. The 10-inch and 12-inch guns are of the disappearing type, mounted on Buffington-Crozier carriages behind earthworks many yards in thickness. These earthworks are faced on the inner side with very heavy concrete walls. Below the gun mounts are the magazines in chambers also built of heavy concrete. The fortifications as a whole are an interesting example of the growing use of concrete for almost all purposes where masonry was formerly employed.

The regular proving ground is located so that firing may be directed toward the sea, save when armor or targets are to be tried. Firing is directed through two wire screens forming part of the Le Boulengé chronograph used for determining the velocity of the shot. When firing out to sea the horizon is carefully watched by the commanding officer through field glasses to see that no vessel is in range. The great shots ricochet across the water in leaps one-half to a mile long, at times throwing a spray of water fully 150 feet high. The report and concussion of a 12-inch gun is not so impressive as the great flash of flame and the peculiar screech of the shell through the air. A flying shell may at times be seen when the light is just right, but it requires a good quick eye to detect it. At the moment of firing the officers and men retreat to the bomb-proofs to avoid injury in case the piece proves defective.

* * *

One of the litle niceties that go to make up a well-designed machine are the dust-proof oil-hole covers which are coming to be adopted by manufacturers of nearly all types of machines, replacing loose plugs or caps, or bare oil holes having no covers at all. These devices not only locate the oil holes for the operator, and make sure that no oil hole will be overlooked, but prevent the holes from becoming clogged, conduct the oil to the right place, keep out dust from the bearing, do not become lost, and are directly responsible for a longer life of the bearing. Such covers have been particularly applicable to machine tools, where accurate fits and alignment are necessary, and to automobiles where dust works into bearings so readily. We find, also, that builders of paper machinery, printing machinery and woodworking machinery are also utilizing covers of the same description because of the superior finish and evidence of attention to details given by such devices to their products.

* * *

Holland has not granted patents for the protection of inventors, being the only civilized country having greatly diversified manufactures which has not thus stimulated the development of new ideas. But this glaring defect is soon to be remedied, steps having been taken by the government to pass laws for the protection of inventions and trademarks.

METAL COLORING.

TREATMENT OF COPPER, BRASS, IRON AND STEEL TO PRODUCE COLOR EFFECTS.

W. J. KAUP.

This is a subject that has received but scant attention in our technical papers, which is rather surprising when we note the natural inclination of the manufacturers of to-day to combine this artistic treatment with utility, and add to the severe straight-line plainness of our commercial product contrast of color, to make it more beautiful. There is nothing new in metal coloring to-day. Ages ago it was old in Japan, and to the Orient we must really turn for original authority on successful coloring of metals. To-day we only imitate the Eastern artisans. This is true, not because we lack the skill and intelligence of the Orientals, for we know full well that the commercial metals of Japan are inferior to our own and that our knowledge of metals from a scientific standpoint far exceeds theirs. It may be that to the very fact of the inferiority of their metals is due their success in coloring, for many impure metals (by that is meant alloys, found by combining two or more metals into one) are peculiarly subject to many variations of color.

For example, copper; commercially pure copper; ordinary commercial copper; or copper castings, when treated with the same solution, will have a different shade of coloring. The most pronounced difference will be found in the copper castings, due to the zinc that is combined with the copper for the commercial reason of obtaining sound castings. In these copper castings the color will be very much darker than in the other varieties of copper.

The purpose of this article is to give to those who are interested results of a number of experiments in coloring metals, solely from the manufacturing side, rather than from the chemist's standpoint. So many conditions enter into the work that no law can be laid down by which everyone can obtain the same satisfactory results, for with everyone the coloring of metals must be more or less of an experimental nature. A cheap monochrome color can be produced by the novice who is unacquainted with the metallurgical properties of metals and chemical actions of solutions used, but the very fact that the slightest change in alloy, as well as in the strength of coloring solutions, produces a different shade of coloring under the same treatment, makes it essential that the operator should have considerable knowledge of metallurgy and chemistry for any except the simplest work.

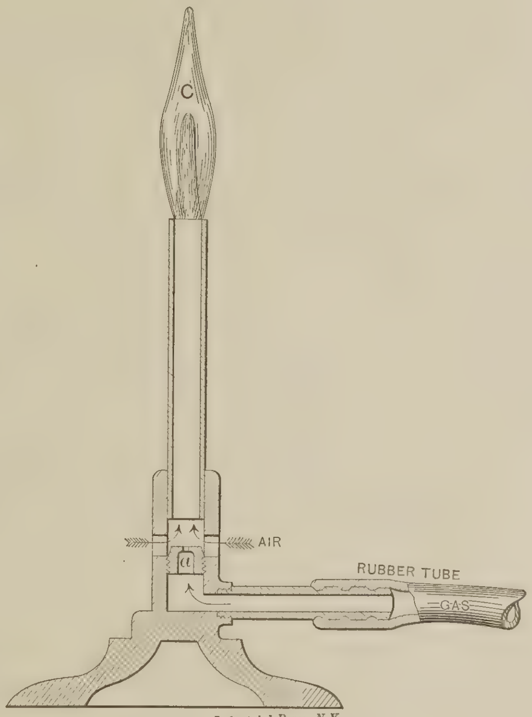
First, let us consider the different methods and conditions under which color can be obtained, viz., by heat treatment alone; varnishes and lacquers; and corroding agents or chemical compounds. We will treat each under its separate heading, but first will refer briefly to the Bunsen burner, by the use of which, together with a pot of heavy fish or lard oil and a pair of tweezers, one can color small pieces by the heat process.

Bunsen Burner.

We will take for granted that some readers, at least, are not acquainted with the Bunsen burner, or at least the principle of its operation. The cut herewith will explain its construction. The idea in this burner is to procure a flame capable of producing great heat, but which will not smoke any vessel or article, heated in it or over it, and if you will carefully note the construction it will be readily seen how this is accomplished. The force of gas, escaping through the small aperture at *a*, draws the air through the holes in the sleeve surrounding the jet. The air and gas mix together, consuming the carbon produced by the decomposing gases before it becomes incandescent, and produces the flame desired. The air is controlled by the sleeve, which turns around the inner tubes, thereby increasing or decreasing the size of the opening through which the air is drawn. A few minutes' use of the burner will enable anyone to get the flame right, but a few points in this regard may be useful. The flame should be about 2½ inches high only. It should not blow. Should burn with blue light, showing defined inner cone of blue-green light, immediately *above* which point *C*, the greatest heat is obtained.

Heat Treatment.

The work over such a burner is necessarily small, such as small screws, bolt heads, washers, pins, etc. The work should be thoroughly cleansed from all grease, either by dipping in a strong hot lye solution or alcohol, then dried in clean sawdust, for it is absolutely essential that the entire surface must present the same physical condition, to obtain uniformity of color. The work should be subjected to the flame immediately above the inner cone of light. Carefully watch the varying change of color and withdraw from the heat before it quite reaches the blue desired, hold in the air until the desired shade appears, then check by dipping in the oil and allowing it to cool in it. Very good blueing can be done in this way, by the beginner, on pieces of uniform shape, but much more skill will be required on pieces where shapes are irregular, large surfaces in one place and small in another, when the heat must be confined to the larger part for a longer period of time than is necessary for the small parts. In such cases the amount of heat contained in the larger part is usually sufficient to produce the desired effect after taking from the flame.



Industrial Press, N.Y.

Section of Bunsen Burner.

Another very common method, especially for flat work, is to heat a flat piece of iron or steel of mass sufficient to retain heat for a long time, and place the piece to be colored on the hot surface, sometimes in direct contact with the hot metal and at other times on a piece of sheet iron placed on the hot piece. When the desired color appears, brush off into an oil bath. Yet another way is the hot-sand method. A pan of sand is heated to a high degree, the parts are buried in it and rolled around, and when color appears check as before. In all these methods the colors that appear to the naked eye come in the following order: Pale straw, dark straw, brown, purple, blue and green, after which it loses itself—in white.

The wearing life of work done by these methods is naturally very short, as the colors rub off very quickly by handling.

Varnishing and Lacquering.

Varnishing and lacquering, as being apart from the subject matter, will be treated very briefly. The method cannot be used to produce an artistic color effect, but is nearly always used for the commercial reason—that of protecting the surfaces of instruments and machines from discoloration by atmospheric influence in which is combined the action of air, moisture and the various gases.

In nearly every instance lacquering is used only on the alloys. It might be well in this connection to note the coloring power of metals in the alloys, as given by Lebedur, a noted German authority. He states that discoloring action upon metals takes place to the greatest extent upon tin and the least upon gold. In the following list of metals the action becomes less from the first to the last: 1, Tin; 2, nickel; 3, aluminum; 4, manganese; 5, iron; 6, copper; 7, zinc; 8, lead; 9, platinum; 10, silver; 11, gold.

Corroding Agents.

We now come to the corroding agents, chemical compounds, by which the really successful results are obtained, by the dipping process, or wet coloring, as it is called. While there are many methods known as dry coloring which have been repeatedly tried, where compounds are mixed together, forming pastes that are applied with a brush and allowed to remain any number of hours and then rubbed off, all are more or less failures. The wet method presents many advantages, both as regards economy of time and uniform results.

To color copper articles, such as ash trays, pin dishes, receivers, etc., a solution of ammonium sulphide will give the best results to the beginner. The greatest variety of colors, from light brown to black, can be obtained by this simple method. Use a dilute solution, cold. A good working solution is produced by diluting a saturated solution of ammonium sulphide with 10 to 40 parts of water.

The light brown color is produced by dipping for a very short time in the solution and withdrawing and allowing to dry in the air. The darker shade of brown is obtained by a longer immersion, according to the color desired, after which dry in sawdust. To obtain a black coloring allow the article to remain quite a little while in the bath and, after removing, dip the article in alcohol, after which the alcohol is burnt off, leaving a black coating. These colors can be permanently fixed by a transparent lacquer. The objection to ammonium sulphide is the great care necessary in handling, as it leaves an indelible stain upon the fingers, and it also has a very obnoxious odor. The ammonium sulphide also decomposes in time, depositing sulphur. It should be kept in a dark-colored and glass-stoppered bottle. It is not good for brass, being adapted only for copper.

Another solution for coloring copper which yields very good results is:

Copper nitrate	1 part
Water	3 parts

This forms a deposit of copper salt and, if heated, the salt is decomposed into a black copper oxide. The greenish tints are obtained by the following solution:

Ammonium carbonate	2 ounces
Ammonium chloride	2-3 ounce
Water	16 ounces

This solution gives good results on both copper and brass, different colorings being obtained by repeated dippings in the solution, allowing ample time between each for the articles to properly dry. As with copper, so it is with brass, many varieties of color can be obtained by different chemical solutions, but the desirable colors for commercial use are dead black and steely gray.

The following mixture has also given very good results for brass:

Hydrochloric, or more commonly termed muriatic acid,
White arsenic,
Silver.

Take any given quantity of arsenic, say ½ ounce, dissolve in strong muriatic acid, snip off a small piece of a silver dime if no other silver is at hand, a piece about ¼ inch in size. Heat the article to a dull red and dip in the solution; allow to remain until cool. This produces the dull black result so often seen on mathematical instruments. The steely gray is obtained in the same manner, except the article is not heated to such a high temperature as in the preceding case. By arsenic solution many good results are obtained by cold dipping also.

In every case where chemical solutions are used it is well to remember that the slower the rate of deposition the better the results, from the wearing standpoint; hence, the longer a dilute solution takes to deposit its coating, the better the color will last, and that is, of course, a very desirable quality.

Coloring Iron and Steel.

The coloring of copper and brass, especially copper, is for its artistic value alone; but from the purely commercial standpoint the coloring of iron and steel is of greater value, because it is used for so many machine parts and parts of guns, small arms, etc., which are treated to produce a blue or black color for the purpose of preserving the metal against corrosion, as well as to give it a handsome appearance.

The following solution will give very satisfactory results with iron or steel if carefully treated:

Take equal parts of potassium nitrate and sodium nitrate and fuse by heating the mixture until it is completely melted. The melting point of the mixed nitrate salts is 339 degrees Centigrade, or over 600 degrees Fahrenheit. Dip the articles first in boiling lye or strong hot soda water to thoroughly cleanse from grease; dip in the hot mixed nitrate flux and from there into boiling water to rinse off the nitrate. Different temperatures of the solution will produce different shades of coloring, and sometimes it will be found advisable to use the flux at a temperature as high as 700 degrees Fahrenheit.

In many cases where tempered articles are to be treated it would not be possible to bring the steel to the desired color by this process, because the temperature of the fused nitrates would be so high as to draw the temper of the articles. In such cases the old nitric acid rusting process is generally resorted to. The nitric acid is placed in an earthenware jar and inclosed in a box that can be made practically tight by closing the lid. The article is suspended in the box and the lid closed, and the fumes arising from the acid oxidize the surface of the article, and if the article is moistened before placing in the box a very much more rapid oxidation is assured, saving considerable time.

Many experiments have been tried with different mixtures for coloring iron and steel, where there is danger of drawing the temper of the metal, of which the following has proved very successful: A wooden box is used, of a size according to the kind of work you wish to do. A small steam pipe connects with the box, so that a quantity of steam may flow into it continuously and moisten the air in the box. A bath made of the following ingredients is then placed in the box:

Iron chloride (muriate tincture of steel)	1 ounce
Alcohol (spirits of wine)	1 ounce
Corrosive sublimate (mercury bichloride)	¼ ounce
Aquafortis (strong nitric acid)	¼ ounce
Blue stone (copper sulphate)	⅛ ounce
Water	1 quart

The vapor arising from this bath forms a deposit on the articles which are allowed to remain in the receptacle a number of hours, rubbed off with a cloth, and the operation repeated if a darker color is desired. Very rich coloring can be obtained by this process, after a little experiment; and the temper is not affected.

Many other solutions more or less successful could be included in this article, but enough has been given to enable anyone to get a variety of coloring in different metals and alloys.

Cleaning Old Brass and Copper.

In conclusion, it will be well to touch upon the method of cleaning old brass or copper from impurities. This is accomplished by what is commonly called a dip. The brass articles are strung on a wire, which should be of the same material as the articles, and dipped in the following solution:

1 part aquafortis (nitric acid).
6 parts muriatic acid (hydrochloric acid).
2 parts water.

The articles are first dipped in a strong hot solution of soda in water, and then into the bath, where they are swirled around for a time, removed and rinsed in cold water and dried in sawdust. If the metal looks dark and is not quite bright, the aquafortis should be weakened.

Where many pounds of small brass fittings are to be treated, they are put in an earthenware pot containing numerous perforations.

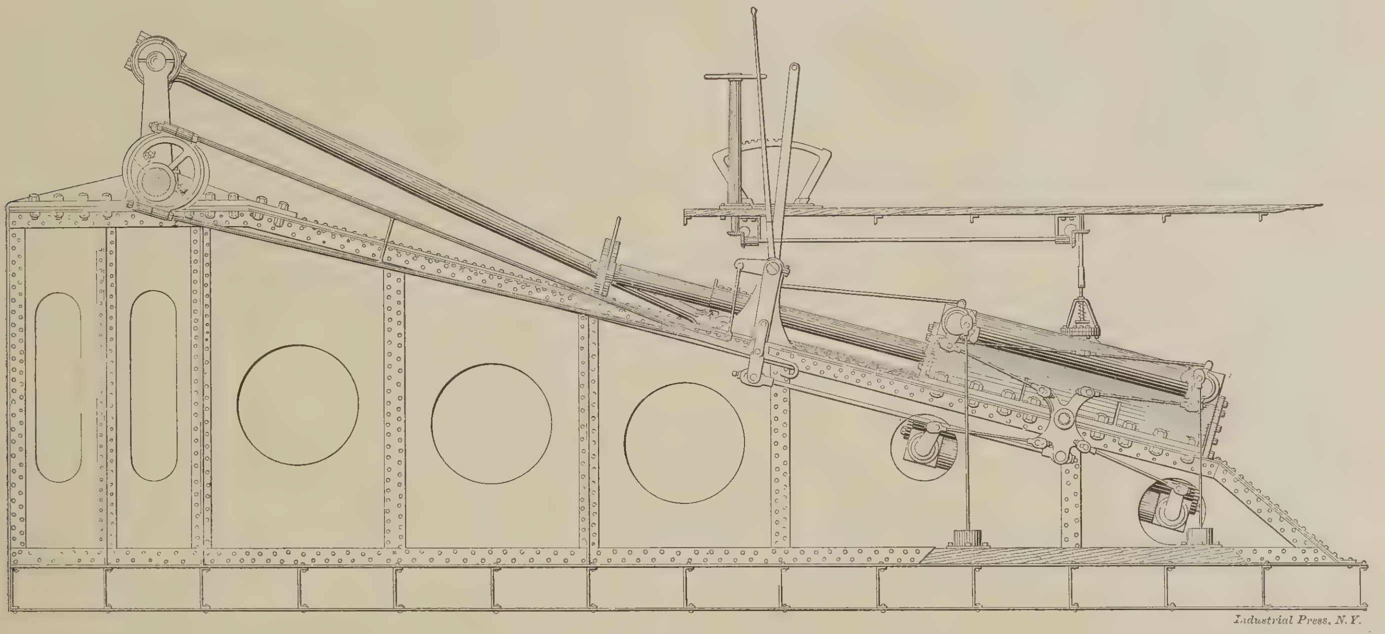
Zinc is often cleaned by dipping into a solution of
16 parts water,
1 part oil of vitriol (sulphuric acid)
for a few moments, and then washing thoroughly to remove all trace of the bath.

* * *

A MARINE ENGINE WITH CORLISS GEAR.

We show in the accompanying illustration an interesting type of river-boat engine that was installed on the steamer *H. B. Plant*, hailing from Port Tampa, Fla., by the Merrill-Stevens Engineering Co., Jacksonville, Fla. It was designed with special reference to extreme lightness, the steamer, complete, drawing only 32 inches of water.

The distinctive feature of the engine is that it is equipped with Corliss valve gear in place of the Stevens gear used so extensively here in the East, and the typical river-boat gear that is found on all the navigable rivers of the West. The Corliss gear gives an opportunity to change the point of cut-off in the engine cylinders, through changing the points at which the knock-off cams operate, without altering in any way the other features of the steam distribution, as shown by the indicator card. This leaves the link motion entirely free for reversal, without regard to steam distribution. Altogether, the Corliss gear appears quite as well adapted to marine work for slow-moving paddle-wheel engines as the more common marine types, and it is rather to be wondered at that it has not been more often applied for this purpose.



Inclined Corliss Marine Engine.

As a general description, the engine is a 24x60 inclined, direct-acting, sidewheel engine, with Corliss valve gear. The engine frame, as shown, is a double steel plate girder, stiffened with intersecting webs, and built into the boat. Nearly all the parts, with the exception of the cylinders and cylinder heads, are steel castings. The guides are hollow steel, 5 inches in diameter and ½ inch thick. The cross-heads have steel casting wearing surfaces, lined with white metal and hang below the guides, which are supported at the cylinder ends by bosses on the head and by steel guide bridges spanning the frames at the other end; the connecting rod is hollow, of forged steel. Main bearings and outboard bearings and wheel-centers all are steel castings, in order to get the lightest possible construction consistent with strength. The piston is a steel casting. The engine is operated with a surface condenser having 600 feet of cooling surface, supplied with circulating water by a direct-connected 6-inch circulating pump, with independent "Burnham" air pump. The performance of the engine has been very satisfactory, indeed; it has been driven at 40 revolutions with 100 pounds of steam, cut-off at 26 inches giving an indicated horse power of 440 and driving the boat at about 12¾ knots. The boiler supplying this engine is a Scotch boiler 8 feet 4 inches in diameter by 12 feet long, having 1,057 feet of heating surface; it furnishes steam for the maximum performance of the engine given above with natural draft, using wood for fuel.

* * *

"FACTOR OF SAFETY."

In the following, taken from a paper on grinding wheels, recently read before a trade association, what seems to us to be misuse of the term "factor of safety," appears:

"Professor Grübler, of Dresden, made a series of tests on abrasive wheels in May, 1902, for the Association of German Engineers. All manufacturers were invited to submit a 20-inch wheel, to be speeded till it burst. About 60 wheels, including nearly all the well-known kinds, were tested, and the results showed that all the specimens were safe if properly used. The proper working speed for a 20-inch wheel is 955 revolutions per minute, and the worst record for any wheel tested was 2,615 revolutions per minute, giving a factor of safety of about 2.7. The carborundum wheel tested gave the highest record, for it did not break till a speed of 4,340 revolutions per minute was reached, giving a factor of safety of about 4.5. This was one of the regular carborundum wheels made with a vitrified porcelain bond."

A factor of safety according to Rankine's definition, is the ratio in which the load that is just sufficient to overcome instantly the strength of a piece of material, is greater than the greatest safe ordinary working load. In this case the factor of safety is applied to the ratio of working revolutions to bursting revolutions. If the centrifugal or bursting stress was in proportion to the number of revolutions or peripheral speed, there would be no particular need for criticism, but the bursting force increases as the square of the velocity, so that in the first case, instead of the factor of safety being 2.7, it is the square of 2.7 or 7.29.

* * *

After certain tests of abrasive wheels made at Sibley College, the metal removed was micro-photographed. The photographs, it is said, show that the metal removed by emery wheels is in the form of minute globules; that from carborundum wheels is in the shape of chips or shavings. This seems to show that an emery wheel "grinds" or wears the metal off while the carborundum wheel cuts it off in a manner much the same as a milling cutter. This is an important distinction. It not only indicates that the carborundum wheel should be the most efficient in metal removed for the same power, but that heating should be much less since it is cut off instead of being abraded by friction. The wheel that heats the least, other things being equal, should give the most accurate work.

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Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

CHICAGO OFFICE—1462 Monadnock Block.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER, 1903.

NET CIRCULATION FOR NOVEMBER, 1903,—25,324 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 or more reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 or more reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

IMPROVING THE STEAM ENGINE.

Not infrequently an editor of a technical paper is called upon to give advice or express an opinion regarding some invention; or it may be that an invention is submitted to him for publication. Very many of such inventions are thoroughly good and must meet with favorable consideration, but there are so many more that are obviously of little value, or perhaps totally useless that it frequently becomes the painful duty of the editor to try to discourage the inventor in his work, and perhaps lose him as a friend for some time to come, or else say nothing at all and let the inventor hang himself with his own rope.

Some time ago we received a letter from a subscriber, inclosing a clipping from the local paper about a steam engine that the writer of the letter had invented. The machine was in operation in the printing office and from the fact that it made the wheels go round and seemed to run very nicely, the editor of that paper wrote a dissertation upon the wonders of the invention and predicted a rapid journey along the road to wealth for his friend, the inventor. The particular merit of the engine was that it accomplished a "long-sought-for method" for doing away with the tremendous losses incident to the crank and connecting rod of a steam engine. The inventor had discovered that designers of all other engines made the great mistake of letting steam into the cylinder at full pressure at the beginning of the stroke, and then cutting off the steam early in the stroke, allowing the pressure to drop to almost nothing at the end. Obviously this is wrong, so he thought, because the steam drops to a low pressure at or near the middle of the stroke, where the crank and connecting rod are in positions to exert the greatest power. Worse than that, the pressure is greatest at the beginning, where the leverage is small, and so, of course, there must be a great deal of power wasted. Why not arrange the valves to give the greatest pressure near the middle of the stroke where the leverage of the crank is greatest, and have the pressure small at each end? And this is what the inventor did!

In another clipping sent us is an elaborate description of a wonderful engine that is certainly an epoch marker. It says, "All mechanics know that the steam engine, as now used, loses one-half its strokes by its reciprocal movement," though we do not quite see what becomes of the lost strokes. The inventor has therefore produced a rotary engine which has no strokes to lose, and which he proclaims "has no motion and makes little noise." The remarkable thing is that it can make even a little noise without any motion.

But the most attractive proposition that has come to hand relates to a new engine which the inventor frankly admits "seems to embody a mechanical anomaly," for, while the mechanism gains power over the crank form of engine it requires less energy in the form of coal to develop power. It promises "to make navigation of the air perfectly practicable, to place the automobile within the reach of everybody who can afford a bicycle, to give railroad transportation the 125-mile-per-hour locomotive, and to give ocean navigation a power that will overcome the momentum of an ocean greyhound in one minute, instead of five minutes now required." He accomplishes this by the simple expedient of a coarse-pitch spiral operated by a nut, which is given a reciprocating motion by the piston rod, and thus saves the 101 per cent. usually lost by the cumbersome crank and connecting rod.

We know that many valuable inventions are made by men who approach a subject from the outside and are untrammeled by custom, or rule-of-thumb. The very fact that they are not familiar with what has been done and the way in which it has been done, enables them to bring a fresh mind to the problem, and to think independently and sometimes more effectively than one whose mental attitude has been influenced by a knowledge of the way others have accomplished a result. But where there is one commercially successful invention by a man not acquainted with the state of the art, there are hundreds that are not successful, and the safe rule to follow—a rule which we should like to impress upon such of our readers as cannot afford to enrich patent lawyers, without some return for themselves—is to first become familiar with what has been done, the way it has been done, and why it has been done. Then, in the light of this knowledge, go ahead with your invention if you think best. We could cite many instances of failures in invention, simply because the inventor acquired his knowledge after the patent was issued instead of before, but the three cases referred to above are sufficient to show what futile schemes a person will spend money on, when a little time devoted to study would have taught him better.

* * *

A press item states that the law in Ohio requiring stationary engineers to pass an examination has been declared unconstitutional. The decision was rendered in the case of an engineer who some months ago was fined for disobeying the law. Dispatches give very meager information, merely stating that the judge declared the statute to be a hardship against those engineers who, by years of practical experience, have thoroughly mastered the practical workings of an engine, but may not be able to answer technical questions.

We have no information about the circumstance of the case. In general, we do not believe in many of the questions commonly asked engineers at examinations. Safety valve calculations, for example, do not amount to anything at all, so far as determining the ability of an engineer to properly operate a steam plant, and many perplexing and useless questions are often propounded that may only serve to confuse a good man. Nevertheless we do not understand on what ground a judge should pronounce examinations unconstitutional. There is scarcely a law on the statutes which might not in some one of its phases abridge the rights of some person and so be "unconstitutional." It should be understood, however, that when a man takes charge of a steam plant he becomes nothing less than a public servant. The safety of the public depends as much upon the proper conduct of his plant and the public has as much right to demand that it shall be safely conducted, as in the case of a hotel, a railroad, a steamship or a mine. These and other public institutions are amenable to public safety and convenience and it is right that every means, legal if necessary, should be taken to protect the public. In the case of the railroad—usually a great system in which it is possible to take men from the ranks and train them for the important positions—examinations for engineers are not so necessary, though the general management of the road must be in conformity to the law. But in the case of individual power plants, owned and operated by Tom, Dick and Harry, who is to insure the safety of the public if the State does not?

HITCHING THE MOTOR.

In machine tools a noticeable feature is the changes in general appearance which the increasing use of the direct motor drive is developing. With lathes especially the first applications of the electric motor concerned the substitution of the motor for belt drive at the countershaft. Next the motor was mounted on a bracket of the machine and connected to the spindle or spindle gearing by means of a chain belt. As yet the lathe itself has not changed. In the later machines, however, the spindle pulley is removed and the motor itself mounted directly in the head—the necessary gearing being disposed around the exterior ends of the motor. These changes, together with those incidental to the modern quick-feed changing mechanisms, make the newest machines present a quite different appearance from the standard forms in general use until quite recently.—*Exchange.*

Contrary to the inference of the above, and unfortunately for the progress of electric machine-tool driving, it is, in the present state of the art, bad design to make an electric motor an integral part of a machine tool. This condition exists because of the still primitive state of the electric motor, which makes it quite necessary to be able to quickly replace a burnt-out armature, etc. If the armature is mounted on a shaft which forms a part of the machine, such as a lathe spindle, for instance, it is special, and its replacement is a matter of days or weeks, depending on the distance from the factory, their promptness, etc. But if a standard motor is used, the replacement of a burnt-out armature, or of the entire motor, is a simple matter. If one make of motor is not available, another generally can be readily substituted. It is true that one of the first attempts at driving lathes with electric motors was made by building the motor in the headstock and mounting the armature on a quill which corresponds to the cone pulley, but this design was a failure. A stroll through the machine shop of an electric concern, well known for their efforts along these lines, will discover a number of engine lathes, originally built with the motors in the headstock, but now equipped with standard motors mounted on the field rings of the old motors. They found that their lathes were lying idle too much of the time, because of repairs to the motors, and so abandoned the idea. When some better means of insulating the windings of motors are discovered than now known, it may be feasible to make them part of the machine tools, but it emphatically is not so now, except, perhaps, in the case of some small tools like grinders or drills.

* * *

LECTURE UPON "THERMIT."

On the evening of Nov. 13 an opportunity was given to hear a lecture by Dr. Hans Goldschmidt on the compound "thermit," at Columbia University. Since the illustrated articles upon thermit in the March, 1903, number of MACHINERY there have been numerous articles and items published upon this wonderful compound in various American papers, and a great deal of interest has been aroused in this preparation and its possibilities.

Dr. Goldschmidt has recently come from Germany for a short stay in America, for the purpose of further familiarizing engineers and chemists with his invention, and it is probable that an American company will be formed in the near future for the manufacture and sale of thermit in this country.

Thermit is a metallic powder, the main ingredients of which are aluminum and oxide of iron, and by inducing a chemical combination of these two elements through the use of a suitable igniting agent such as superoxide of barium, the whole becomes a molten mass at a temperature about equal to that of the electric arc. Ignition once started, the combustion is continued throughout the whole mass of the powder without any external supply of heat. Thermit is applied most profitably, and at the present time most extensively, in various welding operations, although it has certain metallurgical uses of great importance. By suitable preparation of the thermit mixture it is possible by the combustion process to produce pure chromium, pure manganese and other elements used in the manufacture of high-grade steel. It is also employed in the casting of steel ingots and to prevent piping which occurs at the ends of the ingots, due to unequal cooling of the metal in the mold. After the steel has become partially cooled and piping has set in, thermit is introduced near the center of one end of the ingot and by its combustion the steel is heated to a welding point. Steel which is held in readiness is then poured into the cavity and unites with the ingot.

The lecture was highly interesting, illustrated as it was by many experiments and a large number of lantern slides showing practical applications of thermit for welding. At present it is used more extensively for welding street car rails than for any other purpose, although a more striking illustration of its possibilities consists in certain marine repairs that are possible at trifling expense. For example, photographs were shown of stern and rudder posts that had been repaired in a comparatively short time, whereas by the usual method the forgings of which they were a part must have been removed and new ones substituted, while the vessel remained in drydock for several weeks at enormous expense of time and money.

In welding rails the rails are usually held together by suitable clamps, although this is not necessary. The joint is surrounded by a clay mold which fits the rail closely, and the thermit runs from the crucible in which it has been ignited into the mold. The rails reach a welding heat at the joint, and any space between is filled by the molten thermit which itself has a high tensile strength equal to about two-thirds of the strength of the rail; but as the mold is so shaped that the thermit forms a chair for the rail at the joint when it solidifies, it really makes the welded portion considerably stronger than the body of the rail. After the joint is completed the fin of thermit iron formed at the top of the rail at the joint is chipped off.

To say that a full-sized street railway rail was welded in about three minutes' time in the lecture room, as one of the practical illustrations of the application of thermit, will perhaps more forcibly impress upon the reader than any other statement what it is possible to accomplish by the application of intense heat at the point desired, and in just the necessary quantity. In contrast to this we have the labor and time and amount of heat wasted from forge fire by the usual process of welding.

To show the intense heat of thermit a little of the molten metal was allowed to flow upon a wrought-iron boiler plate about ½ inch thick and almost instantly it melted a hole through it 1 inch in diameter.

The experiment that captivated the audience, however, was the illustration of what could be done in welding wrought-iron pipe. It will at once be apparent that the application of such thin metal as is used in wrought-iron pipe would at once melt the metal and leave nothing to be welded. This would be true if thermit were poured directly into the mold surrounding the pipe at the joint, from the bottom of a crucible. Instead the thermit is poured into the mold from the top of a crucible, with the result that the slag formed on top first runs into the mold and adheres to the surface of the pipe, forming a thin layer over the surface. This coating of slag protects the pipe and instead of its melting, it is simply brought to a welding heat. The pipe is held by clamps and when the right temperature is reached the clamps are tightened slightly and then almost at once removed. The thermit iron is easily knocked off from the pipe since it does not adhere to the slag, and a perfect joint is the result.

There is no doubt that thermit and the many uses to which it can be put is one of the most interesting topics that has been brought to the attention of engineers during the past few years. The fact that welding can be accomplished by so simple a process would have been discredited by everyone, especially by those not acquainted with the development in thermo-chemistry previous to Dr. Goldschmidt's work.

In the articles which appeared in MACHINERY last March there were illustrations, from photographs, of welding operations, and the subject was treated so thoroughly that it will not be necessary to go into it more in detail at this time.

THE STEAM EQUIPMENT OF A MODERN SCHOONER.*

Until within comparatively recent times it has been customary for all of the work upon sailing vessels, such as raising the sails, heaving the anchor, etc., to be performed by the sailors; and with an increase of tonnage was required a corresponding increase in the size of the crew, so that one of our present "6-masters," had they then been possible, would have required a small regiment for her operation. The use of auxiliary steam appliances naturally began upon steam vessels where the power was at hand and was, from the first, used for operating the pumps and later for the windlass, ash hoist, etc. Having proved so useful upon these vessels it was not long before it was adopted upon sailing vessels, and at present all schooners of any size are provided with a steam equipment comprising a boiler, used both for power and heating purposes; steam winches, for anchor, sail and cargo hoisting, and an outfit of pumps which forms a complete local waterworks system.

This outfit is located in the "fo'castle," where room is scarce and the arrangement must, therefore, be as compact as possible. Fig. 1 shows a typical outfit such as would be found on the ordinary coasting schooner. The boiler is of the vertical, tubular type, and should be capable of carrying a steam pressure of 100 pounds although, except when raising anchor or discharging cargo, it is usually run at low pressure for heating purposes. A steam whistle is provided so that safety as well as comfort are ensured.

The principal appliance to be installed in the engine room is the steam winch, which is used for handling the cargo, hoisting the boats and for warping the vessel into dock. The engines are of the duplex type with cranks set at 90 deg., so that it is impossible for them to get on "center." The main drum is friction-driven and provided with a powerful band brake, which is used when lowering cargo into the hold. The winch shaft extends to starboard and port beyond the winch proper and, passing through the sides of the deck house, is provided with small drums, or "ends," over which a rope may be run, forward or aft, for sail hoisting, boat handling, or for warping purposes. On the larger schooners two or three auxiliary winches are often supplied, being placed at convenient positions near the masts.

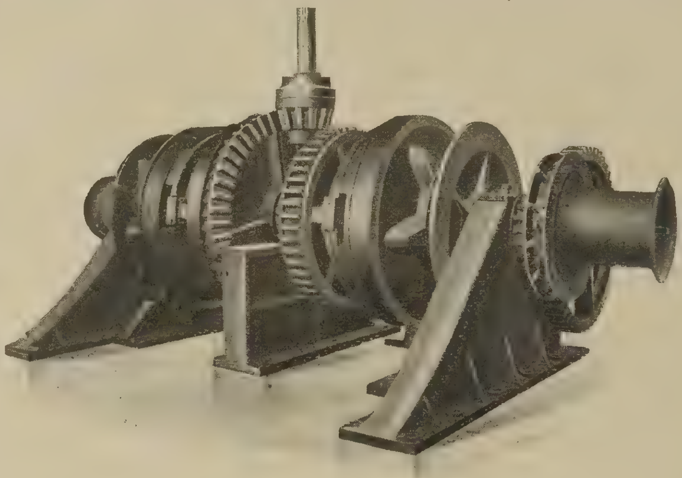

Fig. 2. "Providence" Elastic Windlass (arranged for Messenger Chain Attachment.)

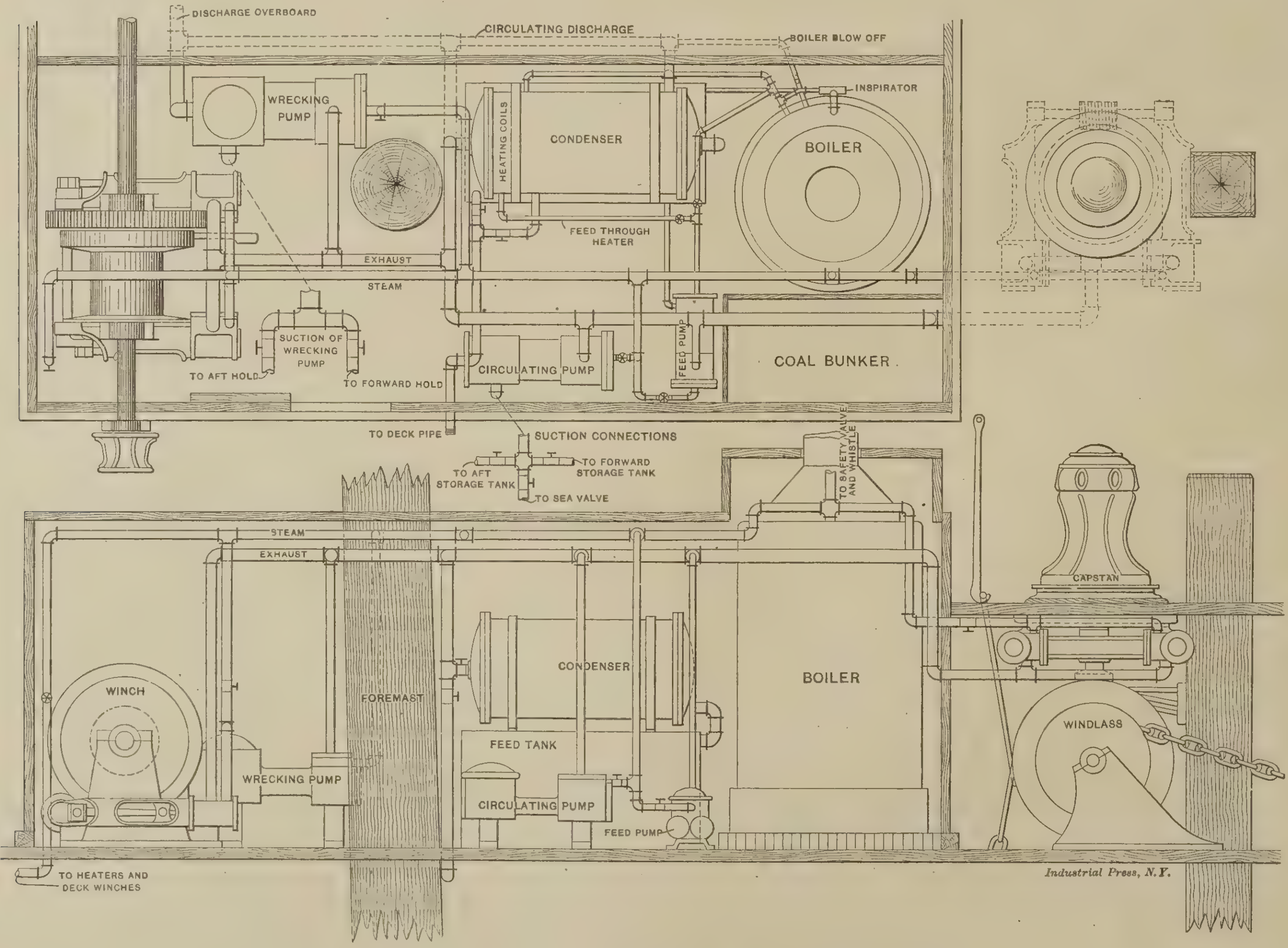

Fig. 1. Plan and Elevation of a Typical Steam Outfit for a Modern Schooner.

One of the most important items to be considered in this class of engineering is the economy of fresh water which must, of course, be carried in tanks and every provision is therefore made to prevent any loss. The supply for the boiler is carried in a tank placed in the engine room, while a reserve supply is held in large storage tanks located in the forward and after holds. Upon the top of the feed tank is placed a coil condenser, to which are connected the exhaust pipes from all of the engines and pumps in the system. Incidentally, the exhaust pipe is continued beyond the condenser, under the deck, and connects with the discharge from the circulating pump so that, in case of accident to the condenser, all of the exhaust steam may be discharged overboard. The first few coils of this condenser are separated from those used for condensing purposes, and are introduced into the boiler feed system so as to form a feed water heater. The remaining coils are connected to the circulating pump, which has a suction connection with the sea valve, and from the condenser the circulating water, as before noted, passes overboard. No air pump is used with the condenser and consequently no vacuum is obtained, as the object of the condenser is solely for water economy. We here find a great advantage in the unlimited supply of condensing water at hand and this is used without stint in order to effect a saving of the valuable fresh water.

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* For much of the information embodied in this article, together with the photographs, we are indebted to the American Ship Windlass Co., Providence, R. I.

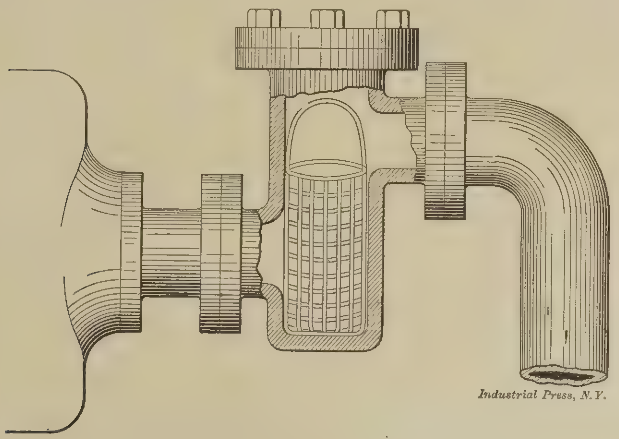

Industrial Press, N.Y.

Fig. 4. Basket Strainer used on Wrecking Pump.

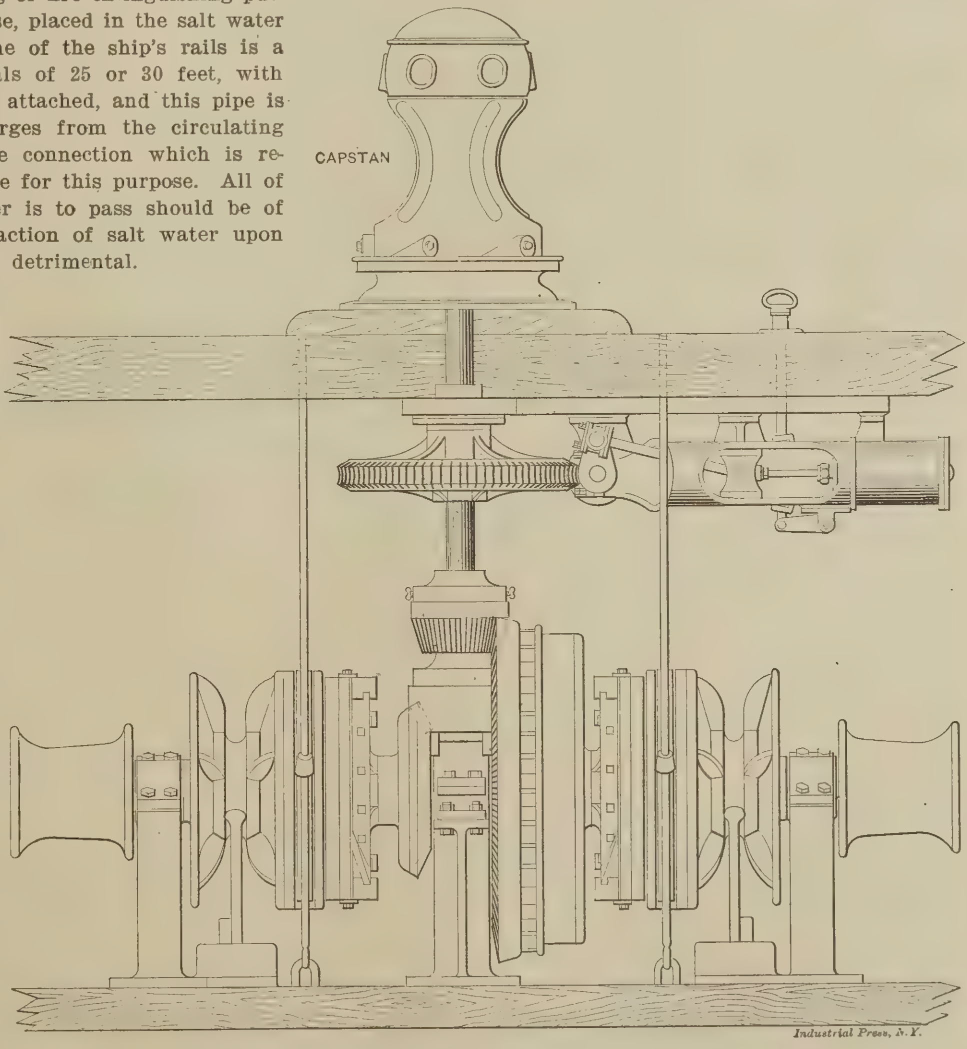
The circulating pump has by-connections whereby the salt water may be cut out and fresh water drawn from either forward or aft storage tank and pumped into the feed tank. This pump is also used for deck washing or fire extinguishing purposes, at which times it is, of course, placed in the salt water circuit. Extending along under one of the ship's rails is a pipe which is provided, at intervals of 25 or 30 feet, with plugs to which a fire hose may be attached, and this pipe is connected with one of the discharges from the circulating pump by means of a flexible hose connection which is removed when the pump is not in use for this purpose. All of the pipes through which salt water is to pass should be of brass or galvanized iron, as the action of salt water upon ordinary wrought iron pipe is very detrimental.

The boiler is fed by a small duplex steam pump and is also provided with an inspirator so that either system of feeding may be employed as desired and the one arrangement acts as a substitute for the other in case of accident. In the engine room is also placed a larger duplex pump which is used solely for wrecking purposes, that is, for keeping the bilge clear of water and when the vessel is leaking. The suction is divided, one part running directly down to the forward hold and the other aft to the after hold. Much care must be exercised in keeping these suctions clear, as it is of greatest importance that they should work freely in case any leaking occurs. A peculiar type of strainer is employed, being what is known as a basket strainer. This is placed in the first elbow of the pipe so that it may be removed and cleaned whenever desired and a surprising quantity of dirt and rubbish, to say nothing of dead rats, is often found in these strainers from the bilge.

Besides the important steam appliances here mentioned, steam from the boiler is also used for heating purposes so that the old fo'-castle" stove is now replaced by a modern steam coil and the captain's cabin aft is provided with radiators, and a bath room supplied with hot and cold water. A telephone also is often installed, establishing communication between the cabin and the engine room.

Last but by no means least of the appliances for which the steam equipment is installed, is the windlass, which is situated well forward and carries the two chains by which the anchors are raised. In the construction of windlasses there have probably been more improvements during the past few years than in any other single appliance used upon sailing vessels. Formerly the windlass was operated by a capstan, in the head of which were inserted long capstan bars. These were manned by nearly the entire crew and with a hearty "heave ho" song they tramped round and round until slowly the cable was wound in and the heavy anchor "weighed." The picturesque part of weighing the anchor is now passed but the capstan is still retained for use in case of a breakdown in the steam equipment. It may also be entirely disconnected from the windlass, by simply removing a block key. We then have an efficient warping capstan operated directly by the windlass engines.

As soon as it became customary to place a boiler and winch on board of a schooner, arrangements were made for connecting the winch to the windlass so as to do away with the necessity of manual labor; and this arrangement consisted of placing a sprocket on the winch shaft and connecting it by means of an open link chain called a messenger chain, to an auxiliary shaft mounted back of and geared to the windlass shaft. Although very serviceable, and still employed to some extent, the arrangement was at best only a makeshift, and gave trouble, owing to the stretching of the chain and its liability to break at just those times that it was most depended upon. A remedy for all of these annoy-



Industrial Press, N.Y.

Fig. 3. "Providence" Elastic Steam Windlass (built by the American Ship Windlass Co.)

ances was found by arranging for the direct connection of the windlass with an auxiliary pair of engines as illustrated in Fig. 3. Upon the windlass shaft is fixed a large bevel gear, which is driven by a bevel pinion on the vertical capstan shaft. Upon this shaft is keyed a worm gear, which is driven by a pair of horizontal engines, similar to those used on the winch, and fastened to the deck above the windlass. The chains pass over chain wheels, called "wild cats," which are loose on the windlass shaft and when paying out chain, or riding at anchor, their motion is regulated by means of friction bands. To raise the chain, block keys are inserted between the wild cat and a driving head which is keyed to the shaft and when the windlass shaft is driven by the engine the wild cats wind up the chain. One of the latest improvements to be applied to the windlass is the use of "elastic wild cats," for the purpose of relieving the strain on the ship, due to its rising on the surges when riding at anchor, and also when breaking out the anchor preparatory to raising. Fig. 6 shows a view of one of the wild cats and illustrates how this is accomplished. Between the driving head and wild cat is placed a secondary head, *A*, which carries four very powerful coiled springs that act as a connecting medium between the wild cat and itself. When the ship is riding at anchor these secondary heads are locked by means of the friction bands, so that no chain can be paid out. As the surge raises the vessel, the strain that would otherwise be brought as a sudden shock upon chain and windlass shaft is instead absorbed in a gradual compression of the springs. This greatly relieves the chain and lessens the liability of its parting. In breaking out the anchor the secondary heads are temporarily keyed to the regular heads, *B*, and the elastic principle again comes into play.

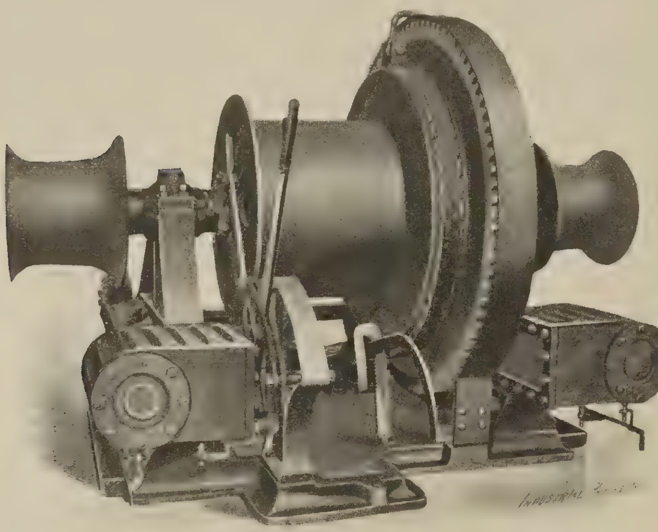
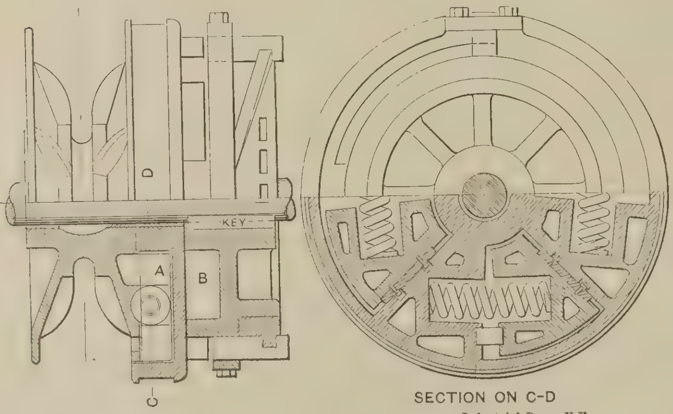


Fig. 5. Seven in. x 10 in. Steam Ship's Winch (built by American Ship Windlass Co.)



Industrial Press, N.Y.

Fig. 6. Section of Spring Head of "Providence" Elastic Windlass.

It would be practically impossible to provide engines of sufficient power in themselves to pull out the anchor when it is securely imbedded in the bottom, but the engines draw in the chain until the vessel lies directly over the anchor with the chain pulled up taut. As the ship sinks in the trough of the sea the cable is tightened still more so that as she rises on the succeeding surge her entire buoyant force is exerted upon the chain and the anchor broken out. The elastic movement of the wild cats, although only about three-quarters of an inch, is yet sufficient to prevent this strain from coming as a heavy shock upon the windlass and changes it to a gradually applied load which the windlass is fully capable of withstanding.

Thus the use of steam upon sailing vessels not only adds to the comfort and safety of the crew but has to a great extent reduced the number of men needed to handle a ship of given tonnage, and made practical the building of greater tonnages than was considered possible when all of the labor had to be performed by hand. The reduced force needed for handling these larger vessels has made the schooner, with full steam equipment, without doubt the cheapest carrying medium for all freight in which quick delivery does not have to be considered.

G. H. H.

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MACHINE TOOL BUILDERS' ASSOCIATION.

The convention of the National Machine Tool Builders' Association was held at the Hoffman House, New York, Nov. 10-11 and resulted in the agreement of the members to maintain existing prices for machine tools, in spite of the possibilities of a depression, resolutions to this effect having been adopted which will be issued in circular form and distributed among the trade.

This convention is looked upon as one of great importance to the machinery market, from the fact that the action in the matter of prices will tend to produce a more stable condition both among buyers and dealers of machinery who have, previous to the convention, not known what to depend upon in this regard.

Several addresses were delivered during the sessions. William Lodge, of the Lodge & Shipley Machine Tool Co., Cincinnati, in dwelling upon the future machine tool trade in the United States advocated the standardizing of parts of machine tools of different manufacture by adopting the same sizes of main bearings, nose of lathe spindles, etc., as well as widths and diameters of countershaft pulleys and countershafts themselves. Under the new order of things, with high-speed steels, he advocated two distinct classes of machines—one for cast-iron work and the other for steel work. He also advocated the maintenance of prices and urged upon the members to work honestly and faithfully to this end.

W. P. Davis, of Rochester, N. Y., related his experiences during a trip in Europe and stated that machine tools were being built at much less cost on the continent than in America excepting where we specialize and manufacture in large numbers, as is generally the case. In Europe concerns tend to produce a great variety of products, which renders them less able to compete. He fears most from Germany, where many large manufacturing plants are going up.

Joseph J. Flather, President of Flather & Co., Inc., Nashua, N. H., read a paper on "What Shall We Do on a Declining Market?" in which he contrasted present conditions with those existing in 1873. There is a great similarity between these periods, both in labor conditions and in the state of the market, but we have the advantage now in that we have stable money. He advocated the maintenance of prices and believed that the machine tool business would hold its own during any depression that may come.

P. E. Montanus, of the Springfield Machine Tool Co., delivered an address in which he held that many branches of the machine trade enjoyed greater advantages and were in a position to make greater profits than were machine tool builders who were producing higher grade products, but were receiving prices small in comparison with many firms building cruder machines by the aid of these tools.

William Lodge was elected president for the coming year; W. P. Davis, vice-president; F. E. Reed, second vice-president; Enoch Earle, treasurer, and P. E. Montanus, secretary.

BLOWING ENGINES WITH MECHANICALLY-OPERATED PISTON VALVES FOR AIR CYLINDERS.

The Westinghouse Machine Company have recently built six blowing engines of the long-crosshead type, three of which have been installed in the plant of the Toledo Furnace Company of Toledo, Ohio, and three at the plant of the South Chicago Furnace Company, at South Chicago, Ill., all under the general direction of Mr. Julian Kennedy, of Pittsburg, Consulting Engineer for the two companies.

These two plants are practically duplicates, each consisting of three engines arranged in line, with the intermediate unit designed to run as a low-pressure engine in conjunction with either of the other two which operate on high-pressure steam, compounding being effected through a receiver in the exhaust system of the high-pressure engines. The low-pressure unit is also arranged to run on high-pressure steam through a reducing valve. These three engines, each of a capacity equal to 2,000 horse power are designed to run in couples, either condensing or non-condensing, one being held in reserve. The steam cylinders of the high-pressure engines are 50 inches in diameter and of the low-pressure 96 inches diameter, and all have a stroke of 66 inches. The air cylinders of all the engines are 96 inches in diameter.

It is interesting to note that the materials entering into the structure of the engines were all supplied under the specifications of the International Association for testing materials. All large and important cast-iron parts were made of gun-iron melted in the open hearth or air furnace and possess a tensile strength of about 30,000 pounds per square inch. All steel castings were thoroughly re-annealed and all important forgings were made of steel, supplied by either the Bethlehem or Midvale Steel companies.

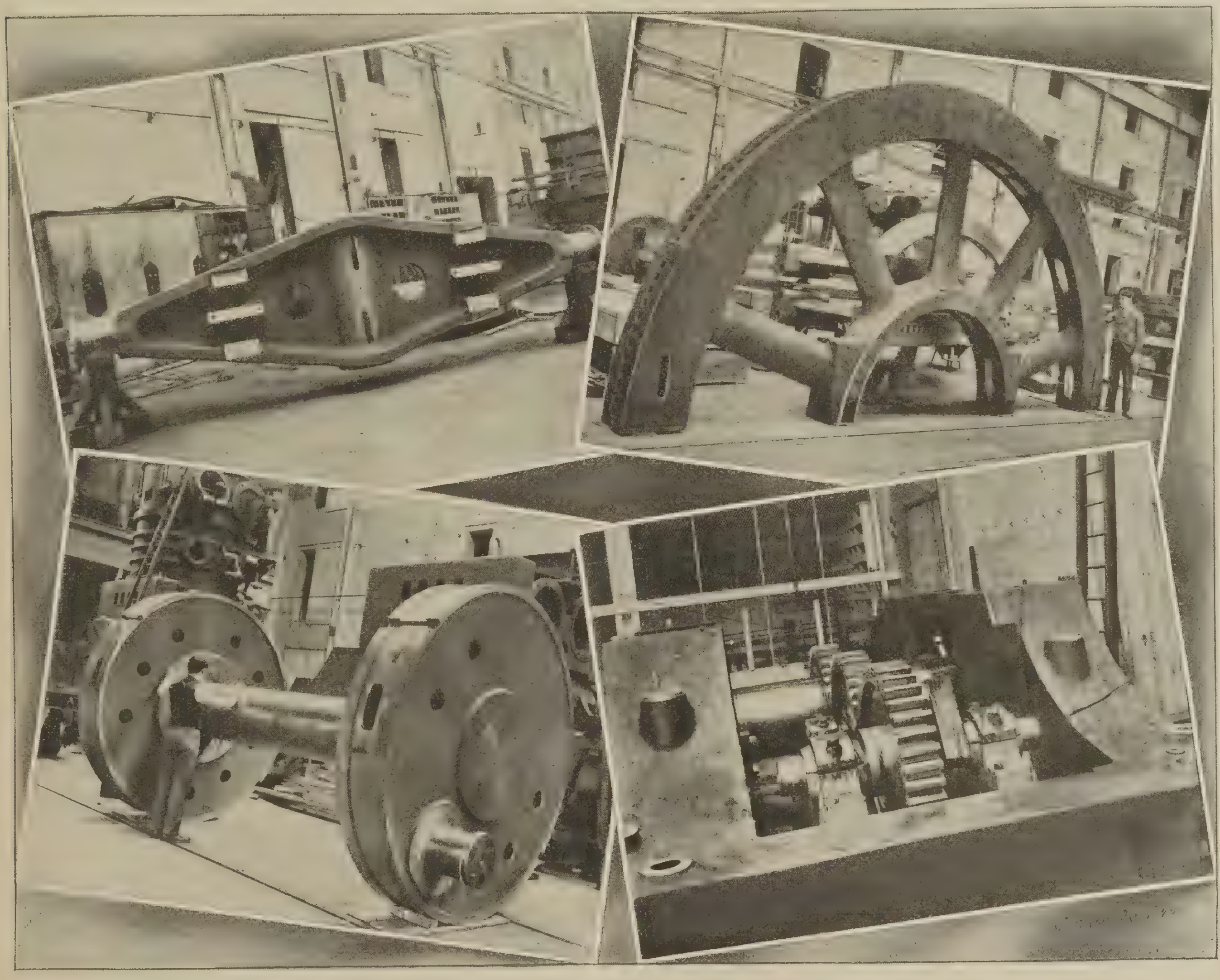

Fig. 1. Engine Details. The Crosshead is a Steel Casting 4 feet deep and 15 feet long. The Crank Disks serve also as Hubs for the Flywheels, which are bored out to fit. The Gearing in Bedplate is for Driving an Auxiliary Crank Shaft for Operating the Valve Gear.

The bedplate is cast in one piece. The bottom portion of the main shaft bearings is a removable shell; these bearings are lined with babbitt metal, pened, both bored to size at one time with a special boring apparatus to insure alignment. Caps for the bearings are in one piece having overhanging lips with scraped fit to prevent side play, and are babbitted. The flywheels are 22 feet in diameter, of air furnace iron, and weigh 63,000 pounds each. The hub of each wheel is a crank disk, faced and turned with a recess on its periphery. The rims and arms of the wheels are cast in halves and counterbored to form a collar which fits into the recess in the periphery of the crank disk. The arms are fastened to the hub by bolts, keyed to prevent turning, and the joints of the rim are secured by internal links.

The main shaft is of hydraulically forged open hearth steel of from .40 per cent. to .50 per cent. carbon. The crank pins are high grade steel forgings containing about .50 per cent. carbon. They were ground true on centers and forced into the crank disks by hydraulic pressure and afterward riveted. The parts which serve as bearings for the connecting rod boxes are 12 inches in diameter by 11 inches long.

Each engine has two connecting rods of open hearth forged steel of from .25 per cent to .30 per cent. carbon, finished all over. They are of the solid end type, each end provided with air furnace cast-iron boxes, babbitt lined and having adjusting wedges so arranged as to take up wear, while maintaining as nearly as possible a constant length. The piston rods are open hearth steel forgings containing .50 per cent. carbon. They are carefully machined and ground true and smooth.

The crossheads are of annealed steel castings of about .30 per cent. carbon. The ends are turned to form crosshead pins, each 12 inches in diameter, 11 inches long. The crosshead shoes are of cast iron, faced with babbitt metal and bolted to the crossheads, adjustment for wear being provided by inserting liners. Especial care was taken in designing the crosshead to have an ample amount of metal, so as to provide a large margin of safety, where the stresses are most severe. The castings were inspected to insure their being thoroughly sound and solid, and the initial foundry strains were eliminated by the annealing process. The pin surfaces were finished true by grinding, and the boring for both piston rod fits was made with a bar at one setting. An idea of the massiveness of these castings may be had from the fact that the depth along the vertical center line is 4 feet, 2 inches.

The crosshead ends of the piston rods are turned cylindrical and are inserted into sockets in the crosshead with a slip fit, so that each strikes the bottom of its socket. A taper steel key is driven through a keyway, cut through the crosshead and rod, to hold the two together, and this keyway is offset in the two pieces so that when the key is driven in it forces the rod with great pressure upon the crosshead at the bottom of the socket. By this means a positive connection is insured, there always being an excess of pressure in one direction, notwithstanding the alternations of stress in the rod, due to the reciprocating action of the engine.

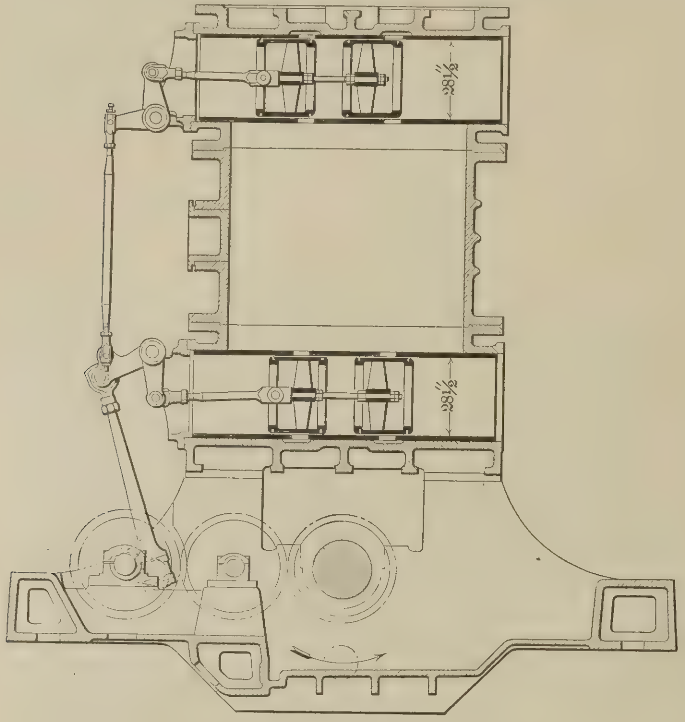

Fig. 2. Section through Air Inlet Valves

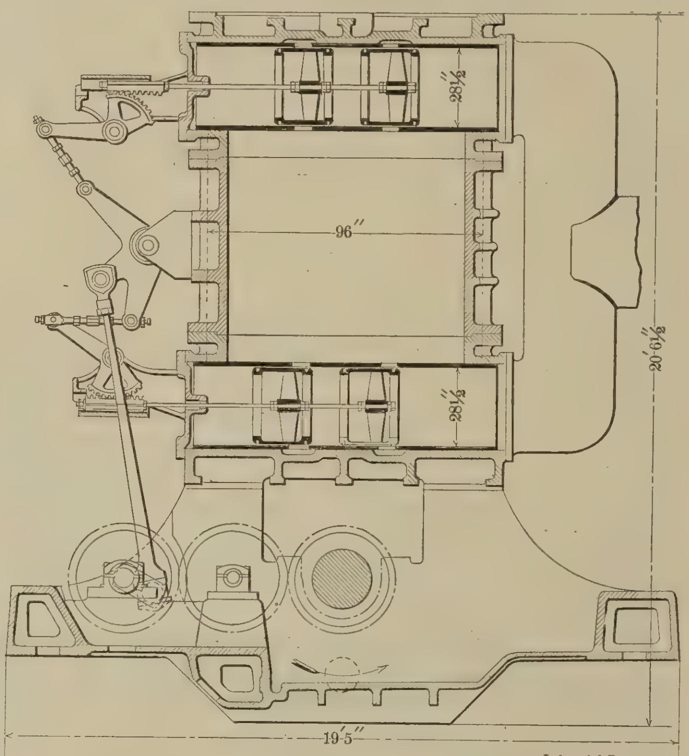

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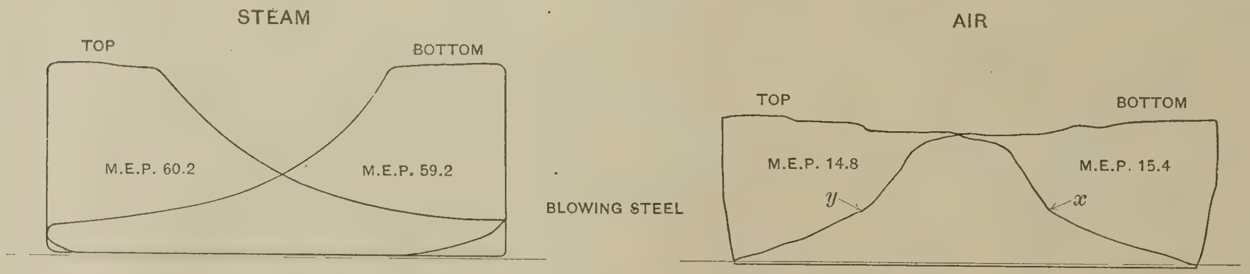
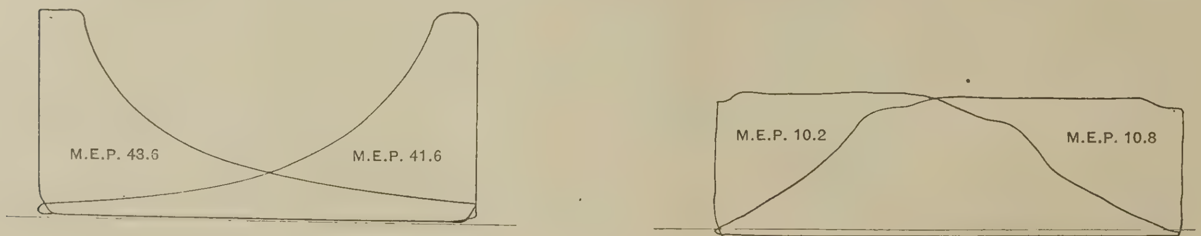
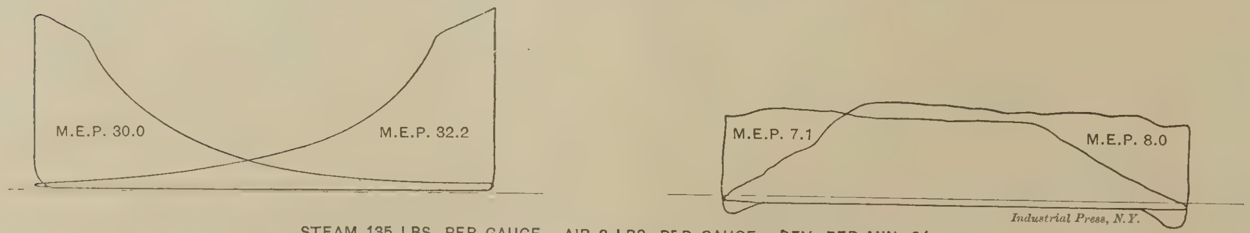
Fig 3. Section through Air Discharge Valves.



STEAM 125 LBS. PER GAUGE. AIR 22 LBS. PER GAUGE. REV. PER MIN. 28



STEAM 130 LBS. PER GAUGE. AIR 12 LBS. PER GAUGE. REV. PER MIN. 30



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STEAM 135 LBS. PER GAUGE. AIR 8 LBS. PER GAUGE. REV. PER MIN. 34

Fig. 4. Cards from the High Pressure Steam Cylinder and the Air Cylinder.

The steam cylinders are of hard close-grained air furnace iron. The walls were cast sufficiently thick to allow of reboring ½ inch diameter larger than called for on drawing. The exhaust box is cast separate from the cylinder and does not come in contact with the walls, thus reducing internal

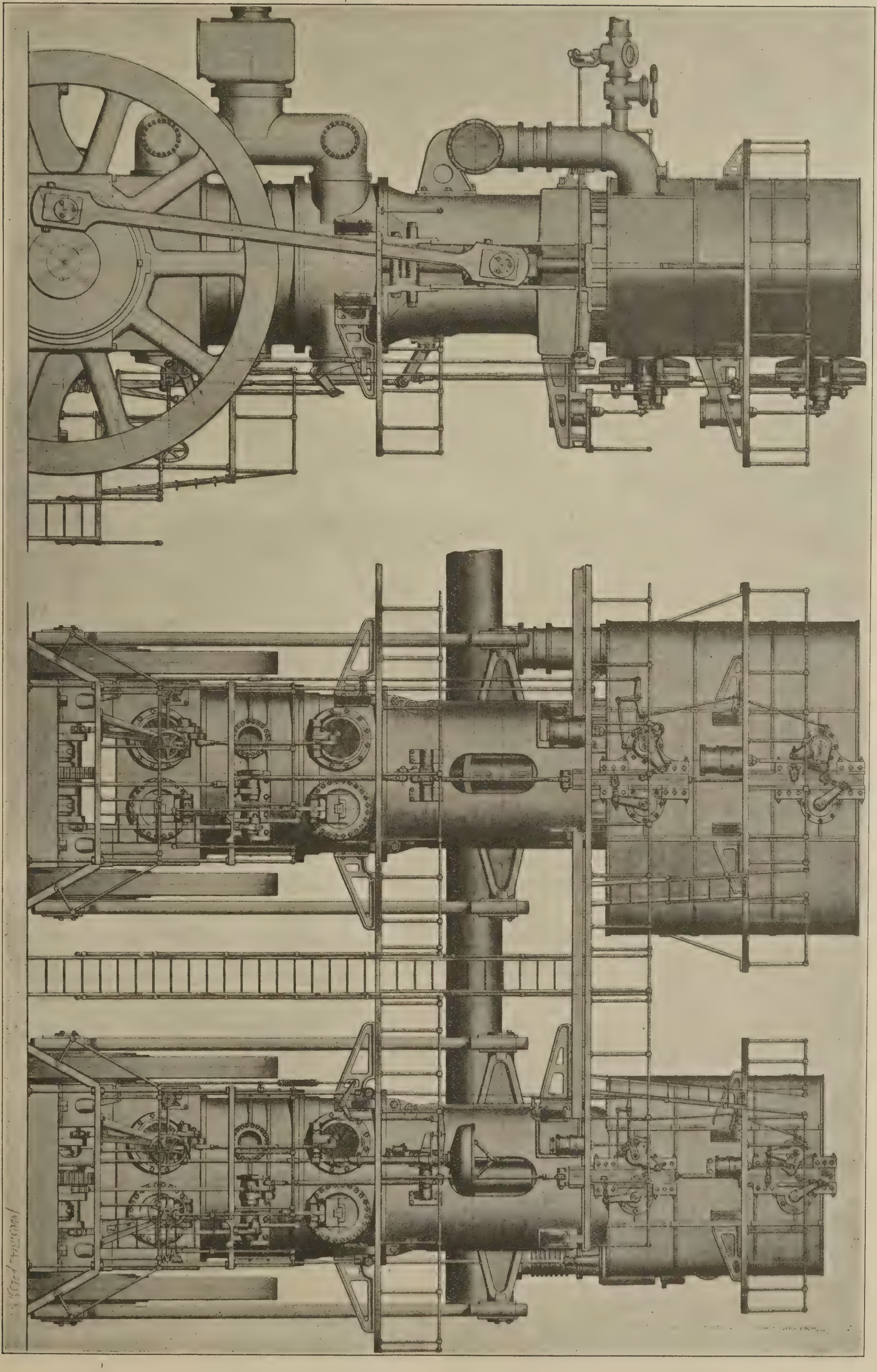

Fig. 5. 2000 H.P. Compound Blowing Engine. Steam Cylinders 50 and 96 inches in Diameter by 66 inches Stroke; Air Cylinders, 96 inches Diameter.

cylinder condensation. Lagging of the best grade of non-conducting metal is provided and the whole is covered with a steel jacket trimmed with corner angles. The cylinder heads contain chambers for Corliss type of valves.

The air cylinders are also of hard, close-grained air furnace iron. The walls are made sufficiently strong to act as the main column or frame work supporting the superimposed parts of the engine. A manhole is in the side and gives access to the interior of the cylinder to allow inspection and removal for repairs of the follower and packing ring, each of which is made in four pieces to facilitate these operations. Each head of the air cylinder is bored and fitted with two cast iron bushings or shells 27½ inches inside diameter, in which positively driven inlet and outlet piston valves operate. Two annular port openings with diagonal bridges are supplied in each shell. The air discharge chamber of each head is provided with a connecting pipe or elbow, and the two elbows unite to form a yoke or Y, terminating in a single outlet 28 inches in diameter, on which is attached a suitable check valve. There are automatic air relief valves in each head, set to operate at 35 pounds pressure. The air piston has two semi-cylindrical concavities running across it on both its top and bottom sides, which fit over corresponding convexities in the cylinder heads that contain the valve chambers. The whole outside surface of the piston head is machined, to reduce clearance at each end of the cylinder.

The air valves and valve motion constitute the most novel feature of the design of the engine. They are of the Kennedy horizontal double ported piston type. Both inlet and outlet valves are 27½ inches in diameter, fitted with cast-iron spring packing rings which were carefully re-turned after cutting the joint, the latter being protected by a keeper.

The inlet valves are operated by a simple harmonic motion through bell cranks. They open when the crank is slightly past the dead center, the piston having by this time traveled about one inch of its stroke, thus relieving whatever compression there may be in the clearance space. They close when the crank reaches the opposite dead center.

The outlet valves are worked by means of racks and sectors driven through a Corliss wristplate, and are arranged so as to give a quick opening and a very long dwell when closed. They are set to begin opening at the time the pressure has risen to 8 pounds per square inch in the cylinder. There seems to be no slip to these valves as they are very tight and close very rapidly.

This valve motion gives an indicator card at 15 pounds per square inch pressure, as nearly perfect as could be attained from an ideal poppet valve, and will operate within a range of from 6 to 20 pounds pressure, with a loss of not more than 1 per cent., due to the fixed point of valve opening, such loss being no greater than that in engines having the best type of poppet valve outlets.

The whole valve mechanism is positively operated and receives its motion from a lay shaft located in the bedplate of the engine, and geared from the main shaft. This lay shaft is provided with cranks instead of with eccentrics to operate the valve motion.

The high-pressure engines are fitted with a Corliss automatic releasing valve gear for the steam cylinders. The steam valves are closed by dash pots. Each high-pressure engine has a governor of the fly-ball type, positively operated by gearing, and has a speed-adjusting device which may be shifted by hand and is of sufficient range to give a speed of from 25 to 50 revolutions per minute, all without stopping the engine. The low-pressure engine is supplied with Corliss trip steam gear adjustable by hand from zero to half stroke.

These engines have been in operation for about three months and although they have not yet run compounded, owing to the incomplete condition of the plants, they show highly satisfactory results as may be seen by the diagrams, Fig. 4, which were taken merely to check the accuracy of the valve setting.

The steam cards were taken from the high-pressure cylinder only, the low-pressure engine not being as yet operated condensing. The air cards were taken simultaneously with those steam cards by the side of which they appear.

It must be borne in mind in examining curves on the air diagrams that both the inlet and outlet valves are worked positively. At the points, x and y, where peculiar breaks in uniformity of the curves occur, the outlet valves are suddenly opened, and beyond these points the engine forces air directly into the air pipes. A number of irregularities appear in the delivery lines at points where the air cylinders of the other engines either begin to deliver air into the receiving pipes or cease to do so.

The total weight of the high-pressure engines is 610,000 pounds and of the low-pressure engines 685,000 pounds, and these weights are thought to indicate that the engines are the heaviest and most substantial of any blowing engines of their size so far constructed.

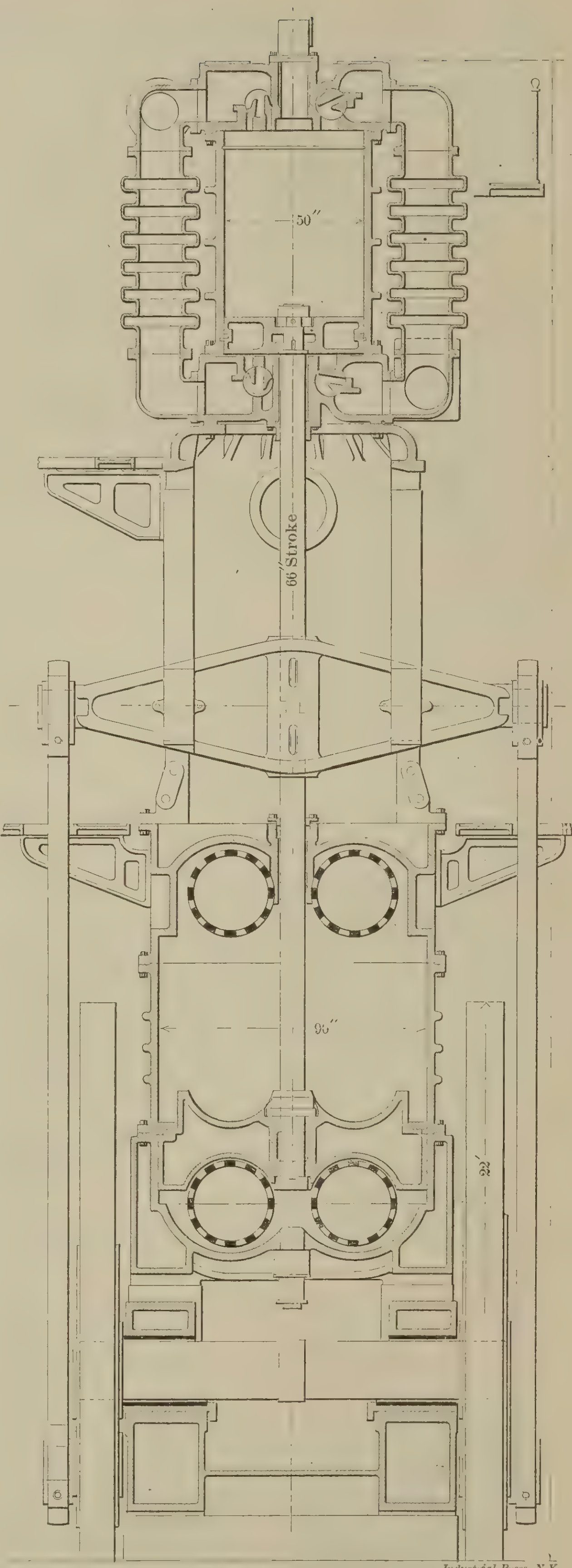

Fig. 5. Section through High-pressure Engine.

WROUGHT PIPE.*

ITS MANUFACTURE, CLASSIFICATION, STRENGTH AND CORROSION.

The development of the wrought pipe industry forms one of the great industrial achievements of the nineteenth century. It had its beginning about one hundred years ago, when the introduction of illuminating gas in England created a demand for pipe, which was promptly met by the manufacturers of gun barrels. The close of the long wars between England and France left on the hands of manufacturers large stocks of this commodity. These were converted into gas pipes by threading the large ends on the inside, and the small ends on the outside. They were easily connected by screwing the small end of one tube into the larger end of another.

The gas pipes of one hundred years ago were lap-welded by hand over a bar or mandrel. The process was slow and laborious.

The several steps were as follows:

1. Preparing a strip of iron of the required width, thickness and length.
2. Scarfing the longitudinal edges.
3. Heating to the proper temperature for bending.
4. Bending or rounding over a mandrel until the scarfed edges lapped.
5. Heating in a forge, a few inches at a time, to a welding temperature.
6. Slipping over a bar, and then hammering the lapping edges until welded.

The last two operations had to be repeated many times before the tube was completed.

The first decided advance in the manufacture of gas pipe was made in 1825, when James Russell, a manufacturer of gas tubes and gun barrels, discovered that a satisfactory weld could be made by butting and squeezing together the edges of a properly rounded and heated strip of iron. This was accomplished by means of a pair of semi-circular dies, slightly smaller in circumference than the width of the metal. As in the lap-weld process, the butt-welded tube was made by alternating heat and welding a few inches at a time.

Coincident with the invention of the butt-weld process of making pipe, Mr. Russell introduced the screw socket or coupling. This was an important step in the evolution of wrought pipe, since it permitted the sections to be made of uniform diameter from end to end.

Present Methods of Manufacture.

John Russell's method of butt-welding pipe was short-lived. It was soon supplanted by an improved process which consisted of drawing the prepared strip of metal, properly heated, through a circular die, thus welding the entire tube at one operation. This is the method of manufacturing butt-welded pipe at the present day, although, of course, many economic improvements have been made since its introduction seventy-five years ago.

The butt-weld process involves the following operations:

1. Clipping the corners of one end of a strip of metal, previously rolled to the required dimensions.
2. Heating to a welding temperature in the welding furnace.
3. Seizing the clipped end and drawing from the furnace with a pair of tongs, over which the operator throws a die or "bell" which drops into the bell holder; then connecting the handle of the tongs by means of a "hook" of special design, to a link of a moving chain which draws the strip through the "bell," thus welding it into pipe.
4. Delivering to a moving table, on which the pipe partially cools.
5. Feeding into sizing rolls, which shape and size to the required diameter.
6. Passing through straightening rolls.
7. Delivering to a slow motion shifting rack, and cooling.
8. Cutting off the ragged ends, and threading.
9. Screwing on couplings.
10. Testing by hydrostatic pressure.

With the development of steam engineering during the second quarter of the nineteenth century, came a demand for pipe of greater strength than the butt-welded pipe of that period. As the hand method of lap-welding was slow and expensive, the feasibility of making lap-welded pipe by machinery naturally occupied the attention of the more progressive pipe manufacturers. After a long period of experimenting, Messrs. Russell had the satisfaction of putting in successful operation, in 1835, the process of lap-welding, which (although somewhat modified and much improved) is used by the pipe mills of the present day. The operations are briefly as follows:

1. Beveling the edges of a strip of metal of the required dimensions.
2. Charging into the bending furnace.
3. Drawing from the furnace at a red heat through a die and over a mandrel, thus rounding the metal and over-lapping the edges. (For pipes of large diameters it is necessary to use bending rolls, similar to those used in boiler shops.)
4. Charging into the welding furnace.
5. Pushing from the furnace by means of a long rod, termed the "push bar," into the welding rolls. These rolls are grooved to correspond with the outside diameter of the pipe. A projectile-shaped mandrel held in position by a long bar, corresponds with the inside diameter of the pipe. As the pipe is drawn over the mandrel the rolls exert sufficient pressure on the laps to weld them. Each pipe as fast as welded is quickly disengaged by withdrawing the bar from the mandrel.

The finishing operations are the same as in the butt-weld process.

The great essential in the manufacture of welded pipe is a properly designed welding furnace, in which the skelp can be brought to a uniform welding temperature throughout its entire length. Next in importance is the personal factor. It is one man's business to see that the skelp is heated precisely to the proper point before it is taken from the furnace. If the temperature is below this point an imperfect weld results, and if overheated the metal is burned or hardened. It is another man's duty to inspect the pipe the moment it leaves the rolls, and to decide instantly and correctly whether the weld is perfect or otherwise. If imperfect the pipe is returned to the welding furnace, and is again passed through the welding rolls. These are responsible positions, and men who can fill them satisfactorily need not be out of employment.

Welded pipe is as small as one-eighth of an inch inside diameter, and as large as thirty-inch outside diameter. There is but one mill in the United States prepared to make the latter size.

This mill (which is now arranging to rebuild its entire plant at a cost of $10,000 000) contemplates making pipe of thirty-six-inch outside diameter as soon as the necessary equipment can be installed.

The minimum thickness of metal used in making lap-welded pipe is determined by the capacity of the tube to resist collapse when heated to the welding temperature. Standard casing and boiler tubes are close, if not quite, to the minimum thickness.

Lap-welding versus Butt-welding.

For many years the butt-weld process of making pipe was confined to the very small sizes, one and one-fourth inch being the maximum. During recent years, however, the process has extended to include larger sizes. At the present time it is the common practice among the pipe mills of the United States to make three-inch pipe and all smaller sizes by the butt-weld process, and larger sizes by the lap-weld process. This statement applies only to standard pipe, since the lighter classes of tubular goods can be made only by lap-welding. The strength of a butt-weld is dependent largely upon the thickness of the metal, and it would seem that the thicknesses adopted for standard pipe are very close to the minimum thicknesses that can be relied upon to give good results.

While it may be possible to make butt-weld pipe larger than three inches in diameter, the cost would greatly exceed that of pipe made by the lap-weld process, and therefore manufacturers have fixed upon three-inch pipe as the maximum butt-weld size, purely for economic reasons.

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* Abstract of paper read before the Pacific Coast Gas Association, by Franklin Riffle, and published in "The Journal of Electricity, Power and Gas."

The question is sometimes asked, "In what respect, if any, is lap-welded pipe superior to butt-welded pipe?" Manufacturers of exclusively butt-weld sizes of pipe assert that butt-welded pipe stands the mill hydrostatic test as successfully as lap-welded pipe, which is perhaps true. The severer test of actual use, however, under varied conditions, has established beyond a question the superiority of lap-welded pipe. Butt-welded pipe may give equally good service when the conditions attending its use are not unusual, but it should not be used for important pipe lines, if for no other reason than for its tendency to open at the weld when subjected to the excessive torsional or bending stresses which cannot be wholly eliminated in the work of laying, especially where tight joints are an important consideration. Therefore, because of its reliability for work of this character, manufacturers use only the lap-weld process in making line pipe.

Screw-joint Pipe.

With reference to weight, or thickness of shell, screw-joint pipe may be divided into four classes of standards:

1. Embracing standard pipe, line pipe, drive pipe and tubing.
2. Extra strong pipe.
3. Double extra strong pipe.
4. Casing.

Taking the weight or thickness of Class 1 as a standard of comparison, and representing it by 1, then extra strong pipe is approximately 1 4-10, double extra strong pipe 2 8-10, and standard casing 6-10; or if standard casing is represented by 1, standard pipe is approximately 1 2-3, extra strong pipe 2 1-3 and double extra strong pipe 4 2-3; in other words, standard pipe is nearly twice the thickness of standard casing, and about 1-3 the thickness of double extra strong pipe, of the same diameter. Classes 1, 2 and 3 have the same outside diameter.

The standard pipe of commerce, commonly known as merchant pipe, is of lighter weight than standard weight or full weight pipe. Manufacturers specify that the latter may have a permissible variation of 5 per cent. above or 5 per cent. below the nominal or table weights. Merchant pipe, however, such as manufacturers and jobbers carry in stock, is almost invariably under the nominal weight. The actual weight varies somewhat among the different mills, but usually lies between the limits of 5 and 10 per cent. below the table weight. Line pipe, drive pipe and tubing are *full* weight, subject to the "permissible variation" of the manufacturer. The same is true of extra strong and double extra strong pipe.

Drive pipe is used chiefly in oil wells, and is designed to stand heavy driving. The ends, therefore, are turned in a lathe, in order that they may meet at the centers of the couplings to form a continuous column, which can be driven without damage to the threads. As tubing is used in wells for pump barrels it is both plugged and reamed to insure a smooth interior.

The smaller sizes of double extra strong pipe are made by driving one piece of extra strong pipe inside of another. The larger sizes, however, are made in the usual way.

Standard casing is the lightest screw joint pipe that can be made. Casing which is made heavier than the standard is termed "special" casing. The increased thickness reduces the interior diameter. Thus the outside diameter of five-inch standard casing is 5.25 inches, and the inside diameter is 4.95 inches. The nominal weight is 8.20 pounds per foot. Three "special" weights of this size are made, weighing respectively 9.86, 12.80, and 15.88 pounds per foot. The corresponding inside diameters are 4.87, 4.75, and 4.65 inches, the outside diameter remaining unchanged. This arrangement permits the use of standard casing couplings and fittings for all the special weights of casing having the same nominal diameter.

Strength of Screw Joints.

The holding power, or shearing strength, of a screw joint is much greater than is generally supposed. When all the threads have the maximum contact, as in taper thread couplings, their combined stripping strength is several times the ultimate tensile strength of the shell of the pipe. This statement applies no less to the fine threads of casing than to the coarse threads of line pipe; but it does not apply to the ordinary straight thread couplings, such as are used on merchant pipe, since in practice the contact area of the threads is somewhat less than in taper thread couplings.

Taking for illustration two-inch line pipe, and assuming the threads to be in perfect contact, the total contact area approximates five square inches, while the metal area of the pipe is 1.07 square inches. Assuming the tensile strength of the metal to be 60,000 pounds, and the shearing strength to be 45,000 pounds per square inch, then the ultimate tensile strength of the pipe is 64,200 pounds, while the stripping strength of the joint is 225,000 pounds. This leaves a wide margin of safety for straight thread couplings, imperfect threads, or carelessness in making the joints.

Steel Pipe versus Wrought Iron Pipe.

The crowning achievement of the pipe industry has been the successful use of steel in the manufacture of wrought pipe. This innovation by one of the leading pipe mills in the early '80's, met with a storm of opposition, not only from rival mills, but from engineers as well.

It was represented that a perfect weld could not be made with steel, that steel pipe could not be threaded, and that it was even more unreliable and treacherous when under pressure than cast iron pipe. As late as ten years ago many engineers refused to accept steel pipe as a substitute for wrought iron pipe, although manufacturers were prepared then, as now, to prove its superiority. Since then engineers have so universally adapted themselves to new conditions that when an occasional non-conformist specifies wrought iron pipe in preference to steel, it is assumed that he has not kept pace with the wonderful progress that has been made in the manufacture of steel tubular goods during the last decade. At the present time manufacturers are producing a uniform quality of steel for pipe, that for malleability, ductility and weldability cannot be excelled by the more expensive product of the puddling furnace, while for tensile strength it is vastly superior to the highest grades of iron.

Many persons are deceived by the high-sounding phrase, "Guaranteed Wrought Iron Pipe." This class of pipe is seldom made of puddled iron. On the contrary, it is oftener made of re-rolled scrap, which contains a varying percentage of steel. If any one desires to satisfy himself regarding the sort of product that results from re-rolling a mixture of iron and steel scrap, such as is collected by junk dealers, let him inspect the fracture of an average bar of so-called "refined" iron. He will probably discover that a considerable portion of the area is crystalline in structure, and that the steel crystals and iron fiber have little or no affinity.

In 1897 Professor Henry M. Howe, an eminent authority on the metallurgy of steel, made a series of experiments for the purpose of determining the relative bursting strength, tensile strength, and frictional resistance of wrought iron and steel pipe. The information derived from these experiments is probably the most reliable and conclusive that has ever been compiled, relative to the comparative merits of iron and steel pipe. Three classes of wrought iron and steel pipe were selected, viz., two-inch line pipe, two-inch tubing, and five and five-eighth-inch casing.

The following table shows in condensed form the average results of the experiments upon bursting strength:

BURSTING TESTS BY HYDROSTATIC PRESSURE.

	Bursting Pressure Pounds per Square Inch.		
	2-inch Lead Pipe.	2 inch Tubing.	5⅝-inch Casing.
Wrought Iron, minimum..........	1000	3300	250
Wrought Steel, minimum.........	2300	5150	1450
Wrought Iron, maximum..........	4000	5000	1400
Wrought Steel, maximum........	6000	6000	2750
Wrought Iron, average of all pipes tested	2918	4106	931
Wrought Steel, average of all pipes tested	4733	5800	2038

A comparison of the average results shows that the steel pipes excelled the wrought iron pipes by 62 per cent. in the line pipe, 41 per cent. in the tubing, and 119 per cent. in the casing.

For making tensile tests short pieces were cut from certain of the steel and wrought iron pipes. These were accurately threaded and fitted with special extra heavy couplings. They were then pulled lengthwise in a tensile testing machine until they tore in two.

TENSILE TESTS.

	Tensile Strength, Pounds per Square Inch of Net Section.		
	2-inch Lead Pipe.	2-inch Tubing.	5⅝-inch Casing
Wrought Iron, minimum........	43,107	47,244	47,312
Wrought Steel, minimum........	63,025	60,370	75,931
Wrought Iron, maximum........	53,809	55,074	61,309
Wrought Steel, maximum........	67,586	66,495	91,591
Wrought Iron, average of all pipes tested	50,002	51,852	54,311
Wrought Steel, average of all pipes tested	65,999	63,057	82,355

The table shows that the steel pipes excelled the wrought iron pipes by the following percentages: Line pipe, 32 per cent.; tubing, 22 per cent.; casing, 52 per cent.

An objection that is sometimes urged against steel pipe is that it corrodes much more rapidly than wrought iron. Of late years this objection has been shown to be based on prejudice rather than fact.

As early as 1895 Professor Howe, in a paper entitled "Relative Corrosion of Wrought Iron and Steel," summed up his analysis of a considerable number of experiments made by himself and other investigators, in the following language: "It is misleading to say either that normal low carbon steel corrodes more or that it corrodes less than wrought iron, since the irrelative corrosion varies with the inclosing medium. I think we have every strong reason to believe that such steel when carefully made, resists corrosion in fresh water as well as wrought iron; in cold sea water, at least nearly as well as wrought iron and in acidulated water better than wrought iron." Five years later Professor Howe published the results of a series of experiments in which he exposed a number of plates of wrought iron, steel, and nickel steel, one-eighth of an inch thick, to the action of sea water, river water, and the weather for two periods of one year each. The results are summed up in the following table:

CORROSIVE TESTS.

	Sea Water.	Fresh Water.	Weather.	Average.
Wrought Iron	100	100	100	100
Soft Steel	114	94	103	103
3 Per Cent. Nickel Steel....	85	80	67	77
24 Per Cent. Nickel Steel....	32	32	30	31

No matter whether we use wrought iron or steel pipe corrosion is a factor that cannot be ignored. Its rapidity of action depends to a very great extent on the chemical properties of the soil in which the pipe is laid. More than thirty years ago the manufacturers of light riveted pipe in California realized that the success of this class of pipe depended upon the application of a satisfactory preservative coating. Judging from riveted pipes that were recently taken up in Oakland after having been in the ground since the early seventies, it was customary in those days to apply the asphalt coating very generously and with great care. Since then manufacturers of riveted pipe, refiners of asphaltum and engineers, have devoted much time and thought to this all-important subject, and at the present day the coating of steel pipe with asphaltum is probably better understood in California than anywhere else in the world.

In view of the importance of the subject the following points are suggested regarding the coating of pipe with asphaltum:

1. The pipe should be thoroughly cleaned. Every particle of rust, and as much of the mill scale as possible, should be removed.

2. The asphalt bath should be brought to a temperature of 300 degrees Fahrenheit. Its proper consistency may be determined by dipping in the mixture a strip of thin steel, and then withdrawing and plunging into cold water. If after this treatment the coating is soft and sticky the mixture contains too large a proportion of the fluxing or liquid grade of asphalt, and if in bending the strip the coating shows a tendency to crack and flake off there is an excess of the solid grade.

3. The pipe should be left in the bath until it has had sufficient time to attain the same temperature as the asphaltum. For the heavy types of welded pipe, it would be advisable to heat each pipe to the same temperature as the bath before immersing.

4. As a thick coating of asphaltum affords more thorough protection than a thin coating, two dippings are recommended, in which case the first coating should be allowed to harden before re-dipping.

5. Pipe should be coated in the vicinity of the laying. Under no circumstances should it be dipped before leaving the mill, except as a precaution against rusting en route, in which case it should be re-dipped at destination. After the pipes receive their final coat the greatest care should be exercised to prevent abrasion, both in distributing along the trench and in laying. As a final precaution every pipe should be rigidly inspected for abrasions, and wherever exposed, the metal should be given two coats of some reputable brand of asphalt paint.

Specifications.

Engineers sometimes prepare elaborate specifications for pipe without stopping to consider if they are practicable. So far as the quality of the material and the details of manufacture are concerned, it is always advisable to conform to the practice of the best pipe mills. All grades of steel, for example, are not equally weldable. Therefore it would be a waste of time to specify steel that could not be welded.

So far as testing the pipe at the mill is concerned the standard hydrostatic tests for the several classes of pipe will answer, unless extraordinary working pressures are contemplated. The standard tests are as follows:

Standard, extra strong and double extra strong pipe, two-inch and smaller, 300 pounds per square inch.

Standard, extra strong and double extra strong pipe, two and a half inch and larger, 500 pounds per square inch.

Line pipe, six-inch and smaller, 1,500 pounds per square inch.

Line pipe, seven-inch to twelve-inch, 800 pounds per square inch.

Tubing, 2,000 pounds per square inch.

Irrigation casing, five and five-eighths inch and smaller, 500 pounds per square inch.

Irrigation casing, larger sizes, 300 pounds per square inch.

Oil well casing, five and five-eighth inch and smaller, 600 pounds per square inch.

Oil well casing, larger sizes, 500 pounds per square inch.

Unless otherwise specified the several classes of pipe are tested at the mill to the above pressures. Arrangements can always be made for special tests when the pipe is to be used under high pressures. In no case should the mill test be less than one and one-half times the proposed static pressure.

Specifications for merchant pipe. The following specifications are sufficient to secure a good quality of merchant pipe at the ruling market price. Pipe to be made of good, ductile metal of uniform quality, and to be straight and smooth. Threads to be clean cut in accordance with manufacturers' standard. Couplings to be well screwed on. Jointers not to exceed 8 per cent. of the total number of lengths. All pipe to be subjected to the standard hydrostatic test before leaving the mill.

Specifications for line pipe. Pipe to be made of steel, of tough, ductile and uniform quality. Each length to be fitted with a full weight line pipe coupling, the ends of which shall be recessed. The threads of the coupling to taper uniformly from both ends to the center. A half-coupling thread protector to be securely screwed on to the exposed end of each length of pipe. None of the pipe to vary more than 5 per cent. above or 5 per cent. below the standard weights. Jointers not to exceed 6 per cent. of the total number of lengths. Each length to be tested at the mill to a specified hydrostatic pressure.

* * *

The *New York Times* in an article on post office oddities refers to the manufacture of stamps and tells its readers that the original steel plate bearing a stamp design, although *baked* as hard as a diamond, is never used for actual printing.

FLEXURE SIMPLIFIED.*

JOHN S. MYERS.

Most mechanics and even a few draftsmen, especially those engaged on machine tool work, know very little about the theory of flexure or strength of beams. They may know that the maximum bending moment in a beam uniformly loaded equals $\frac{\text{weight} \times \text{length}}{8}$ and that for a beam with concentrated load in the center, maximum moment equals $\frac{\text{weight} \times \text{length}}{4}$ because they have seen the formula in some book but could not tell you why such is the case; or if they had a problem the book did not cover, could not work it out. Moment of inertia, section modulus, radius of gyration and extreme fiber sound too scientific to them and seem too hard to tackle. As a matter of fact the whole thing is comparatively simple when divested of technical terms and put in a simple form.

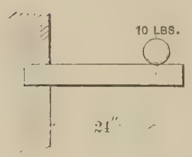

Fig. 1.

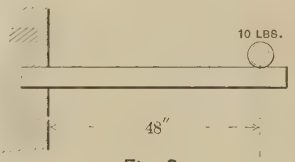

Fig. 2

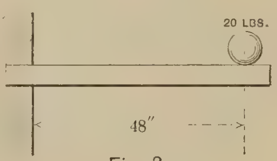

Fig. 3

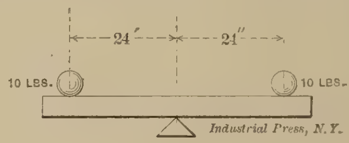

Fig. 4

The first thing we have to consider is moments. The word moment almost explains itself. It means importance, or of account, in ordinary talk, and in mechanics, when applied to a force, it means the importance of the force, with respect to bending; that is, it is a measure of the ability of a force to bend. A force of ten pounds at the end of a beam 24 inches long has a certain definite power to bend the beam. The same force 48 inches or twice as far from the support we at once say has twice the power to bend the beam. Twenty pounds 48 inches away from the support we would say had four times the power to bend the beam, for we have twice the load and twice the distance from the support.

The power of a force to bend is called a bending moment and is nothing more or less than the force multiplied by the distance from it to the point where we wish to determine its power. In Fig. 1, the bending moment at the support is 10 × 24 = 240 inch pounds. In Fig. 2, 10 × 48 = 480 inch pounds. In Fig. 3, 20 × 48 = 960 inch pounds.

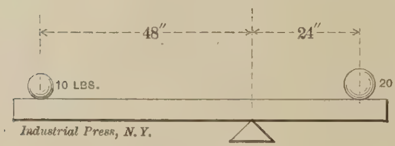

Fig. 5

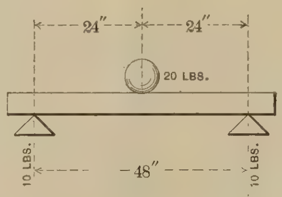

Fig. 6

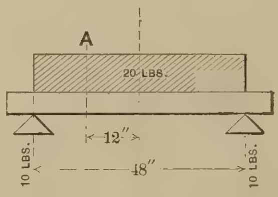

Fig. 7

Now we come to the principle of the *equality of moments.*

In Fig. 4 the beam is evidently balanced, as equal weights are equal distances from the fulcrum or point of support. The moment on the left is 10 × 24 and on the right 10 × 24. There is no tendency to move either way, so we say the beam is in *equilibrium.* In Fig. 5 the moment at the point of support for the force on the left is 10 × 48 = 480 inch pounds, and for the force on the right 20 × 24 = 480 inch pounds. The moments are equal so we see this beam is in equilibrium since the moments express the power of the forces to turn about this point. In Fig. 6 we have 20 pounds in the center and half of this or 10 pounds at each support. This force at the end, which acts upward, is called a *reaction.* The bending moment at the center of the beam is 10 × 24 = 240 inch pounds, just the same as in Fig. 1.

In Fig. 7 we have a reaction of 10 pounds upward at each end also, and the moment of this about the center is 10 × 24 = 240 inch pounds, but half the load on the beam, the center of which is at *A*, acts downward and has a moment in the other direction of 10 × 12 = 120 inch pounds. The net moment at the center then is 240 − 120 = 120 inch pounds. This is what is called the *algebraic sum* of the moments. It is all the moments in one direction minus all the moments in the other direction on one side of the point under consideration, and expresses the power of all the forces to bend the beam at this point. By a similar method we may find the bending moment for any character of loading.

Now the beam must of course be able to resist the bending moment, and the power of a beam to withstand flexure is termed the *resisting moment,* which of course must equal or exceed the bending moment.

We will take the case shown in Fig. 8, where a force of 5,000 pounds acts in the center of a beam 200 inches long. The reactions are of course 2,500 pounds each, and the bending moment 2,500 × 100 = 250,000 inch pounds. All that portion of the beam above the line *y y* is in compression and all that portion below *y y* is in tension and at the center the stress is zero, as indicated by the arrows. This line *y y* is called the *neutral axis.* Now if we divide the entire area of a cross section of the beam up into small parts and multiply the area of each part by the stress per unit of area at that point and then by its lever arm, *x*, we would have the resisting moment of the beam. This would be laborious, however, and it is the maximum stress at the outer edge called the *extreme fiber stress* that we wish to find. If we multiply each of these elementary areas by the square of its distance from the neutral axis *y y* and take their sum we have the quantity called the *moment of inertia* and if we divide this quantity by the distance *C* we get the quantity called the *section modulus.* Section modulus may be said to be the area equivalent to the total area of the section if concentrated at the extreme fiber and multiplied by its lever arm. We readily see that this equivalent area times its lever arm, when multiplied by the stress per unit of area equals the resisting moment of the beam; or in other words, section modulus × stress = resisting moment, which is also equal to the bending moment or $ZS = M$ where Z = Section modulus, S = unit stress and M = bending moment. As we have seen before, $Z = \frac{\text{moment of inertia}}{C}$ usually written $\frac{I}{C}$. The section modulus Z for different shapes has been worked out to simple formulas; for a rectangle like beam in Fig. 7 the formula is $Z = \frac{BD^2}{6}$. Now to find the size beam for conditions in Fig. 8, we take our formula $ZS = M$ or $\frac{M}{S} = Z$ and inserting the values of M and S, allowing say 1,000 pounds per square inch for S, if a pine timber, we have $Z = \frac{250{,}000}{1{,}000} = 250$. But for a rectangle $Z = \frac{BD^2}{6}$, so $\frac{BD^2}{6} = 250$ or $BD^2 = 250 \times 6 = 1{,}500$. Now we can assume some breadth and figure for the depth or assume some depth and figure for the breadth. If we took a beam 10 inches deep, it would have to be $\frac{1{,}500}{10^2} = 15$ inches wide; if we took a beam 12 inches deep it would have to be $\frac{1{,}500}{12^2} = 10.42$ inches, say a 12-inch by 10-inch timber. If we wanted to use an I-beam with a stress of say 16,000 pounds per square inch for dead load, we would get $Z = \frac{M}{S} = \frac{250{,}000}{16{,}000} = 15.63$, and from tables in the handbooks of steel concerns we see that an 8-inch, 23-pound beam or a 9-inch, 21-pound beam would answer the purpose. The foregoing simple application should be enough to start one on the right track and the writer hopes it may be of use to someone struggling for the truth under adverse circumstances.

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* This simple explanation of the flexure of beams is to assist the younger readers in the use of this month's data sheet.—EDITOR.

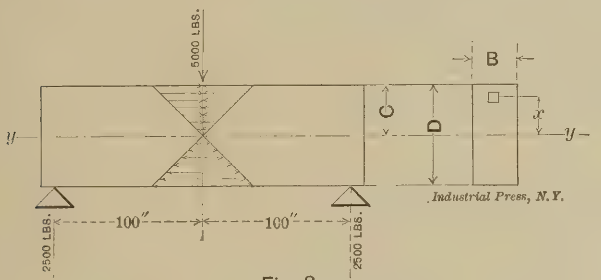


Fig. 8

* * *

DOUBLE-ACTING PUMP.

Editor MACHINERY:

The pump illustrated in your issue of October, 1903, page 90, is a hoary old friend of mine. As your correspondent states that W. H. Wilcox & Co., of London, England, have been exhibiting it lately it might be well to correct the probable impression that it is new.

Thirty years ago I was engaged in steam pump building and patented several improvements; so I was interested in finding the simplest double-acting pump possible. Some time afterward, but more than twenty years ago, I proceeded to build a pump—intended to be the limit of simplicity—as follows:

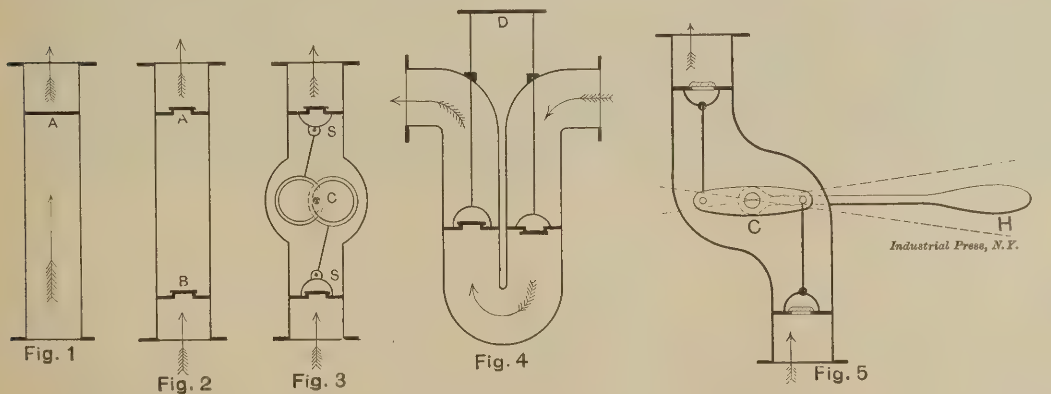


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5

Simple Double-acting Pumps.

Let *A* be a piston in a simple piece of pipe, Fig. 1. If *A* is moved upward as per arrows we have a pump, but only till the piston reaches the top end of the pipe. Now, it becomes necessary to take a new hold of the water, but there is nothing to hold up the column while this is being done. I then evolved the arrangement, Fig. 2, putting in two pistons, *A*, *B*, in each of which there is a valve opening upward and imagined that while *A* is going down *B* is coming up, and *vice versa*. In other words, the pistons, *A*, *B*, approach *to* and recede *from* each other alternately and a solid stream is discharged. I then put stirrups on the pistons, as in Fig. 3, and used two opposite eccentrics on center shaft, *C*, connected with the pistons, as shown. This I built and tested and found to work better at high speed than any double pump I ever saw.

At no period of my life did I ever feel so certain that I had the material for a fundamental patent; so my application was at once sent in. It would be safe to say that no enthusiastic inventor ever got a more beautiful reference from Washington, for the office sent to me a complete drawing of my model with two cranks instead of my two eccentrics—patented in 1860 (No. 27,945)! Applying this old claim to Fig. 3 it would read thus: "The shaft, *C*, its two cranks, in combination with the two connecting rods and the valved buckets, *S S*, and their valves—so that a simultaneous reciprocating motion, in contrary directions, may be imparted to the said buckets, *S S*, by the rotation of the shaft, *C*, and so that the two barrels may be in direct line with each other." "Bucket" is the old name for a piston containing a valve. The "Wilcox" drawing is substantially the same as the drawing in this old patent. In 1857 (No. 17,625) a modification appeared as per Fig. 5, shaft *C* having a simple crosshead, as shown. Outside the case was placed the lever, *H*, to be moved through any convenient angle, by hand, as indicated by the dotted lines. This pump, in whatever form, with the "motion" working in the water, is not of much practical value and is only good when bent into a U, as in Fig. 4, and the two pistons operated in the same direction from a crosshead, *D*, common to both. For this successful form see MACHINERY, August, 1899, page 367. But to *all* these forms there is a fundamental objection. Assume that the displacement by one of the pistons, while its valve is seated, is x: then through the other piston, during the same time, $2x$ of water must pass. In other words, when any one of the pistons is taking water through its port (or valve) it is *meeting* a stream of its own velocity in the opposite direction. It is not usually evident at first glance that the action of pump, Fig. 4, is the same as Figs. 3 and 5, yet such is the fact. JAMES ARTHUR.

The Arthur Co., New York.

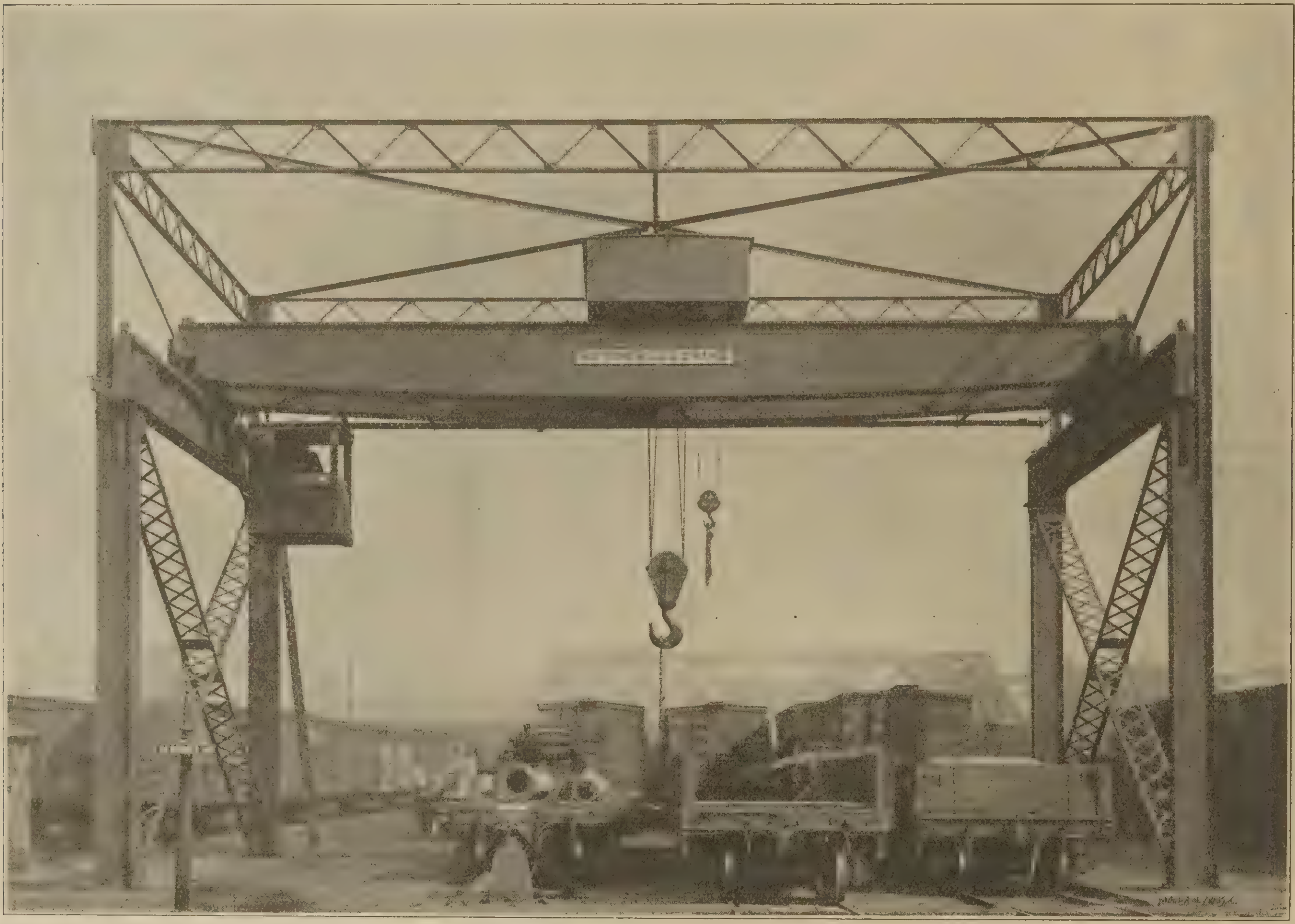
* * *

NILES FORTY-TON TRAVELING YARD CRANE.

A cut given on next page shows the latest type of an improved and economical apparatus for the handling of heavy and bulky freight in a railroad yard. The view shows a portion of the yard of the Buffalo & Allegheny Valley Division of the Pennsylvania Railroad Company, at Buffalo, N. Y., and includes a four-motor Niles overhead electric traveling crane, 48 feet span, and a substantial structural steel runway 40 feet long. The crane spans three tracks, and leaves a wide passageway which gives ample approach for teams and trucks on one side of the cars covered by this apparatus. The height of the runway gives the main hook a lift of 24 feet. The motor operating the main hook is 30 horse power.

In addition to the main hook, a quick running auxiliary hook of 5 tons capacity, driven by a 21 horse power motor, is provided for the rapid and efficient handling of light loads, which performs by far the greater part of the service of the crane. The bridge consists of two heavy curved girders, of box section. It is driven longitudinally on the runway by 30 horse power motor located on the front girder which is geared to the truck wheels on either side, the motion being controlled by a foot brake located in the operator's cage which acts directly upon the armature shaft of the motor. A foot bridge is provided the entire length of the span, with customary guard rail. The bridge trucks are of built-up type, securely fastened with the utmost rigidity to the girders, provided with heavy cast steel double flanged truck wheels with treads accurately finished to uniform diameter.

The trolley, traversed on the bridge by a 7½ horse power motor, is the standard type used on overhead cranes, consisting of heavy side frames securely bolted together and kept in perfect alignment by a separator. All the gearing is cut from the solid, and runs encased in oil, which gives the entire mechanism an unusually high mechanical efficiency. Both hoists are provided with mechanical and electric brakes, also circuit breakers and limit switches to prevent overwinding and consequent damage to the crane or its load. The trolley, operator's cage, and bridge drive motors are of the inclosed type, affording suitable protection from the weather. The runway, it will be noticed, is of substantial construction. It consists of four built-up columns carrying runways of riveted plate and channel construction, laterally braced by overhead struts and chords of lattice construction. The speed of the main hook lifting full load is 9 feet per minute; light, 18 feet. Auxiliary hook, full load, 50 feet; light, 100 feet. Trolley travel across bridge, with full load, 80 feet; light, 100 feet. Bridge, full load, 225 feet; light, 275 feet.



Yard Crane in Use by Pennsylvania Railroad at Buffalo.

It will be readily appreciated that an equipment of this character has a much greater capacity than the average pillar or swinging crane which, where any is in use, is usually installed at railroad freight stations. If at any time it is desired to cover increased acreage with the hook, the length of runway is readily increased by adding additional spans. This crane is notable because of the extra height of lift, 24 feet, which enables the loaded hook to clear the top of box cars or other obstructions while performing the functions of its regular service of loading and unloading.

The complete apparatus was manufactured, installed and erected by the crane department of the Niles-Bement-Pond Company, Meadow and Mifflin Streets, Philadelphia, Pa.

* * *

In annealing cold rolled steel, gas is turned into the annealing boxes after they are removed from the furnace. The burning of the gas uses up any air that might come in contact with the steel while cooling. By this method the steel comes out of the boxes in bright condition.—*Sparks from the Anvil.*

HYDRAULIC INSTALLATIONS.

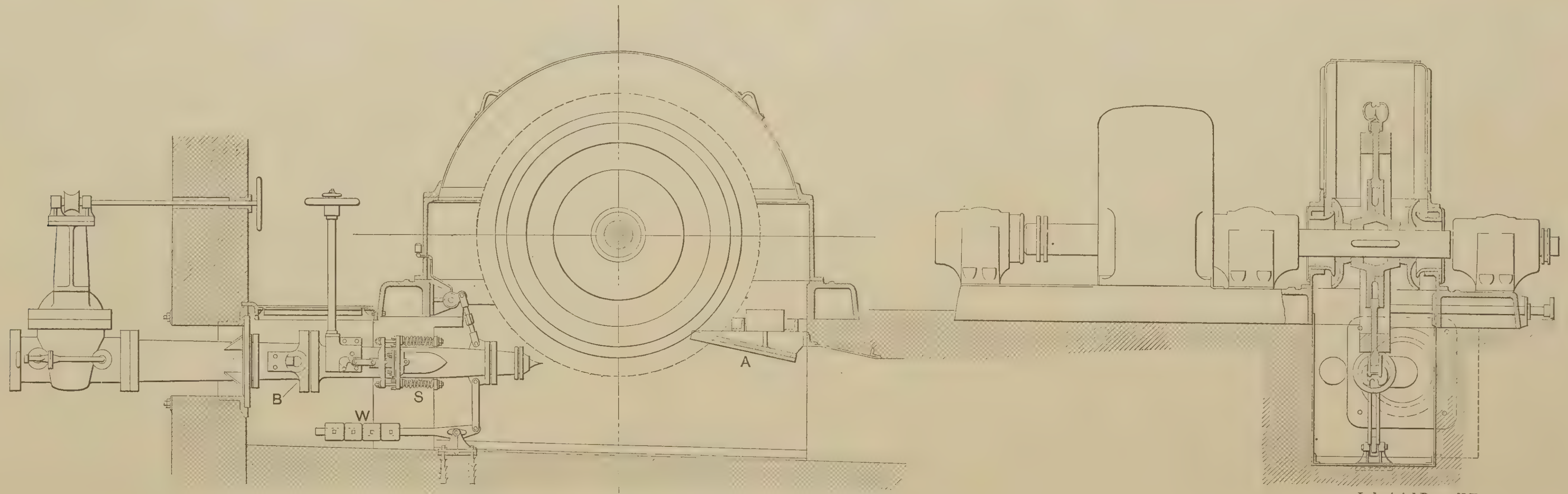
REMARKABLE WATER POWER ON THE PACIFIC COAST.

Recent development in hydraulic practice on the Pacific coast has been in the tendency of the utilization of higher heads. In the minds of a number of engineers the question has arisen as to the wisdom of developing these high heads, utilizing the totality of fall in one station, as against dividing the fall up and passing the water through two or more stations in series, in this way utilizing the same water under lower heads in two or more power plants.

The Edison Electric Company, of Los Angeles, had this problem to consider when it was proposed by them to install their new power plant, which has been known as Mill Creek No. 3 being located in the Mill Creek Canyon, near Redlands, Cal. The effective head on this plant is 1,912 feet. After carefully considering the matter the Edison Company decided that it would be better engineering to utilize the total available head in one power station, although it is the highest or greatest head it has ever been attempted to utilize in this manner. Water falling from a height of 1,900 feet would theoretically have a velocity of flow of over 20,000 feet per minute and it would be necessary for a tangential water wheel to have a peripheral speed of nearly half this velocity; as a matter of fact the wheels now running in this plant have a peripheral speed of between 9,000 and 10,000 feet per minute, or upward of a mile and three-quarters a minute.

The plant to be installed was to consist of four water-wheel generating units of 750 kilowatts each, designed for a 25 per cent. overload, at a turning speed of 430 revolutions per minute. They therefore decided to install at first but two units, the balance of the plant to be placed after tests had been made in the first two wheels. Accordingly they placed an order for one unit with the Pelton Water-Wheel Company, San Francisco, and one with the Abner Doble Company, San Francisco, makers of the ellipsoidal tangential water-wheel.

We are informed by the Abner Doble Company that the balance of the equipment for this station was finally purchased



Industrial Press, N.Y.

Tangential Impulse Wheel for Operating under the Highest Head yet Utilized—1912 feet.

from their firm and they have kindly furnished us with particulars about this and other important installations of the Doble ellipsoidal tangential wheel, together with a blueprint of one of their Mill Creek wheels direct-connected to an electric generator.

The Doble wheel installed at the Mill Creek station showed an efficiency on the preliminary tests of from 80 per cent. to 84 per cent., at loads ranging from one-half load to 25 per cent. overload. The installation is of particular value in confirming the wisdom of the Edison Electric Company in utilizing their total head in a single station as against dividing it up over several stations, as has been done by several other companies. It is demonstrated by the tests at this plant that the efficiency to be secured from tangential wheels under these very high heads is exceedingly favorable, clearly showing that it is safe to utilize the total available power value in one station. These tests make an interesting comparison with the work of one of the famous Swiss builders in the Vouvry plant, where the efficiency was only 56 per cent.

The illustration on this page of one of the Mill Creek wheels shows a 1,300 horse power wheel with needle regulating and deflecting nozzle designed to operate under an effective head of 1,900 feet. The generator base plate is extended to carry a third bearing for the electric unit and the housing of the water-wheel. The water wheel itself has a diameter of 7 feet 8 inches, and one single nozzle is applied, furnishing a stream of 2 inches maximum diameter. The wheel body is of the composite type, a steel disk being clamped between the hub and follower plate, and carrying two heavy cast steel flywheel rings, rigidly bolted to it.

The nozzle is of the deflecting needle regulating type, the regulating needle being operated by hand by means of a hand wheel with worm-gear attachment; whereas the Lombard governor used for regulating the wheel, but not shown on the drawing, deflects the nozzle and turns the stream down into the tail race, partially or entirely away from the buckets, according to the load on the generator. The regulating needle in this case has the purpose to increase the area of jet during periods of peak load, which occur in the evening, when to the normal load considerable load is added on account of lights being switched in.

The power station furnishes the light and power for Redlands and Los Angeles and smaller places between, a considerable part of the power being used to operate centrifugal pumps to irrigate citrus groves in that part of the country.

The engraving shows how the connection is made with the gate valve outside of the power house, the operating spindle going through the wall in such a way that the operator has both the handwheel for the gate and the handwheel for setting the needle within easy reach.

The sectional end elevation at the right corner of the drawing also shows the centrifugal water guards applied to avoid stuffing boxes, which cause unnecessary friction. These water guards serve the double purpose of preventing splash water escaping from the housing, and at the same time ventilate the housing to maintain an easy flow of water in the tail race. The casting shown in the front elevation of the drawing is a baffle plate, through whose opening the buckets pass. The purpose of this baffle plate is to shave off the last particles of discharge water emanating from the buckets.

The needle, by which the size of stream flowing through the nozzle is regulated, has a long stem extending back longitudinally through the body of the nozzle. At the forward end the stem is enlarged and formed into a cone which, by the longitudinal movement of the needle, opens or closes the mouth of the nozzle. The spiral springs, *S*, at the side of the nozzle, are to equalize the varying pressure on the needle cone in the different positions of the needle or at different nozzle openings. The needle stem is provided with a balancing plunger which extends into the pressure chamber of the nozzle body and balances the needle at normal opening.

When the needle is entirely drawn back or the nozzle full open, the pressure on the springs is released as the pressure on the balancing plunger and the forward pressure on the needle bulb are equal. By shutting the nozzle or moving the needle forward in reducing the area of the issuing jet the reaction decreases, whereas the forward pressure remains the same. To make up for this variation, the compression springs are provided, which are fully compressed when the needle is entirely closed and in which case the forward pressure on the bulb is a maximum. On account of this it takes the same power to operate the needle wherever its position might be.

As stated at the beginning, the Mill Creek plant, of which one of the power units is shown in the illustration, is operating under the greatest head of any similar plant in the world, and it will be of interest to add a few facts about the impulse wheels recently built by the Abner Doble Company, for use in connection with the Bay Counties transmission system, which are the largest impulse wheels ever constructed, so far as we are aware. Last summer two wheels were installed at the Nimshaw Power House of the Valley Counties Power Company, a sub-company of the California Gas and Electric Corporation, and feeding into the transmission line of the Bay Counties Power Company. These two machines have now begun operation.

The power house is located in the Butte Creek Canyon, twenty-four miles from Chico. The available total head of water is 1,531 feet, taken down in one pipe line 6,200 feet long, and tapering in three sections, from 30 to 28½ inches diameter. Within the power house the pipe terminates in a Y, each branch of the Y supplying a 3,700 horse power water-wheel, the largest wheels operated as yet by one single jet of water.

The generators are of the Stanley Electric Company's make, the rotary element mounted on one single shaft with the water-wheel; the entire hydro-electric unit runs in two bearings, the rotary element of the generator between the bearings, and the water-wheel overhung. Shaft and disk are nickel steel forgings, made by the Bethlehem Steel Company, the shaft being hollow-forged and oil-tempered, and the buckets are steel castings of the ellipsoidal type. The total weight of the revolving part of each unit is over forty tons; the speed 240 revolutions per minute.

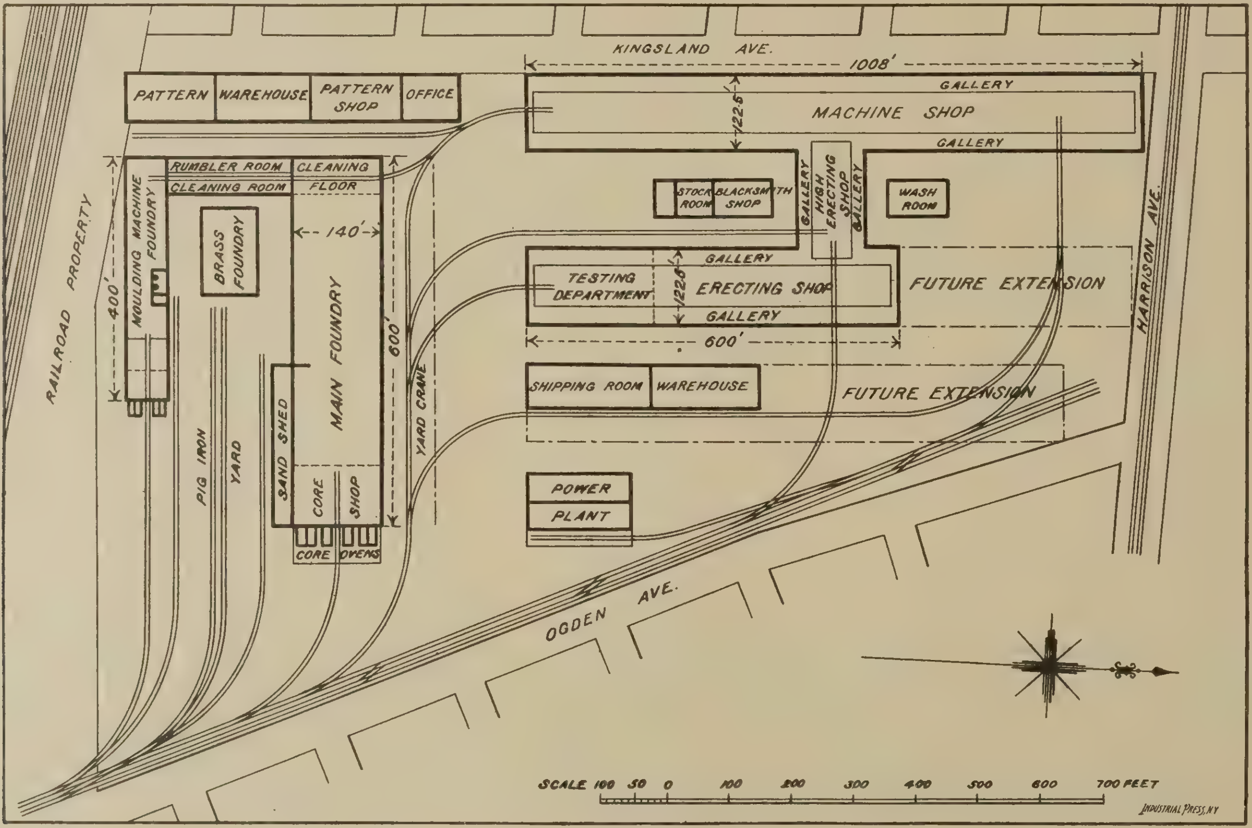
The Abner Doble Company is now building, however, a unit of 7,500 horse power to operate under the same total head of 1,531 feet, for the Bay Counties Power Company, which thus considerably beats their own record. It will be direct-connected to a Stanley Electric Company's alternator, and will run at a speed of 400 revolutions per minute, the entire hydro-electric unit being mounted on two bearings and one single nickel steel shaft. The wheel takes water from a single nozzle.

* * *

THE NEW WORTHINGTON PLANT.

An extensive pump manufacturing plant, the largest in this country and probably in the world, is now under construction at Harrison, N. J. It is to be occupied by the firm of Henry R. Worthington, who employ about 3,000 men in their present works at South Brooklyn, L. I., and Elizabethport, N. J. The new plant at Harrison covers an area of about 30 acres, facing Harrison avenue, and will employ from 4,000 to 5,000 men. The total cost will be in the neighborhood of $2,000,000.

It consists of a main machine shop with side galleries over 1,006 feet long, an erecting shop 592 feet long and of the same section as the machine shop and a high erecting shop 210 feet in length and four galleries in height in the side bays connecting the two shops. The main foundry is 600 feet in length and there is also a special foundry for small work, 410 feet in length, with a building 200 by 60 feet in size, for cleaning castings, connecting the two. The pattern building is four stories high and 550 feet long, and is divided by fire walls into four sections. The north section will be used for offices and drafting rooms, the adjoining section for the pattern shop and the balance of the structure for pattern storage. The power house, which will be equipped with the best modern boilers, engines and generators, is a building 172 by 102 feet. Five generators are to be installed having a total capacity of 2,500 kilowatts. Electric power distribution is to be employed throughout, and the grounds will be illuminated by electric arc lights. There are many other buildings which will be used for packing, storing and shipping goods, etc. The buildings are so arranged that additions can be built when the work demands it. All will be connected by a complete system of railroad tracks entering the ends of the buildings and placing the works in direct communication with the Delaware, Lackawanna & Western, the Erie and the Pennsylvania railroad systems. The new plant will be devoted entirely to the manufacture of water works machinery, water meters, cooling towers, condensers, feed-water heaters, centrifugal pumps and steam pumps of all kinds. It is expected that at least three of the buildings will be ready for occupancy about January 1, 1904.



Plan of the Worthington Plant of the International Steam Pump Company.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Beginning with the January, 1904, issue the name of *Feilden's Magazine* will be *The Engineering Review.*

In a paper on foundations read by Mr. George B. Francis before the Boston Society of Civil Engineers, February 18, 1903, some elementary information on permissible loads per unit of area were given as follows: Ledge rock, 36 tons per square foot; hard pan, 8 tons per square foot; gravel, 5 tons per square foot; clean sand, 4 tons per square foot; dry clay, 3 tons per square foot; wet clay, 2 tons per square foot; loam, 1 ton per square foot.

The gross earnings of the railways in the United States for the six months ending June 30, 1903, were the largest in the history of railroading in this country. The increase in gross earnings for this period was over $90,000,000, and of the net earnings, somewhat less than $20,000,000. The increased cost of operation due to higher wages, and of fuel and other supplies, have had the effect of keeping the increase of net earnings down to a little more than twenty per cent. of the increased gross earnings.

The extending use of aluminum for electrical purposes and the wide prospective use for it in the manufacture of thermit, makes the report that a St. Louis man has discovered a pyrochemical process of manufacturing aluminum from clay of considerable interest, especially so as he claims the metal will be greatly cheapened by the new process. The process, discovered by Mr. Schwahn, is claimed to effect the reduction in much shorter time than now required and to reduce the cost from $500 to $100 per ton.

A somewhat novel plan for balancing a loose pulley is described in the *Woodworker.* After the pulley has been bored out ready for use, place it upon a smooth arbor that is solidly supported in place. Wind a cord around the hub, or the rim, according to size of pulley, and give the cord a long, even pull, that unwinds it, giving the pulley the motion due to unwinding process. The inner end of the cord is not tied to the pulley, but left free, except that the cord crosses it to hold the same in place. When the pulley is perfectly balanced it will run a long time without "chattering."

The Ellwood Ivins Tube Works mills at Oak Lane Station, Philadelphia, have succeeded in producing tool steel seamless tubing. The tubing is made in sizes from about 2 inches in diameter down to small sizes of 1-64 inch, in all thicknesses of walls. The tubes are most accurately drawn both as to internal and external diameters, and have a polished surface. So great is the precision that it is claimed that no work is required for fitting the tubes after they are made in sizes ordered. It would seem that this new product in tool steel would eliminate the necessity of boring out solid rods or bars where either short or long hollow articles were required, such as cutting dies, bushings, drills, etc. These steel tubes take a high temper at low heat.—*Iron Age.*

The largest circular saw in the world has just been turned out at the works of Henry Disston & Sons, in Philadelphia, for use in the lumber section of Elk county, Pennsylvania. The saw is 7 feet 4 inches diameter and bears teeth each one of which is 4 inches long. The saw weighs 305 pounds. The purpose for which the mammoth saw was made is of interest. It will be used to cut pine stumps into shingle bolts, thus opening to the market a vast quantity of material which until recently was considered useless. In Elk county, where thirty years ago the forests of white pine were hewn down and turned into lumber, are thousands of acres of great pine stumps as solid as the day the trees were cut. Many of these stumps stand from 5 to 8 feet above ground, so that in the swampy regions of the Elk county plateaus there are millions of feet of choice shingle wood.—*The Woodworker.*

A German casehardening process described in a recent consular report by Consul-General J. O. Hughes, Coburg, Germany, employs phosphorus in connection with the other ingredients of the pack, to impart a greater hardness. The effect of the phosphorus is said to be to weaken the coherence of the surface particles of the iron and to thus facilitate the absorption of carbon. The pieces to be casehardened are packed in cast-iron boxes in the ordinary manner, the cover being tightly closed and luted with clay. The pack consists of bone dust, yellow prussiate of potassium, cyanide of potassium and phosphorus. An example is quoted to show the proportions. To caseharden pieces weighing say, 400 pounds, 300 grains of yellow prussiate, 250 grains of cyanide and 400 grains of phosphorus are mixed with the necessary amount of bone dust to properly and economically harden the work. It is said that the surface hardness obtained by this process is phenomenal.

An accident, illustrating the danger of not having main valve connections carried through to the upper decks of steam vessels, occurred to the *Picqua,* October 10, off the American coast during a heavy storm. The main steam pipe broke off close to the cylinder, filling the engine room with scalding steam and causing the death of two men. For two hours the vessel rolled at the mercy of the seas, the engines having stopped, and the steam still pouring through the broken pipe until the fires were finally extinguished. At last it was possible to enter the engine room and effect a temporary repair of the broken steam pipe, so that the vessel could proceed. Had there been connections to the main steam pipe valves from the upper decks, the danger of the accident would have been greatly minimized and perhaps the lives of the men saved. Connections to all important valves from the upper decks is one of the details that Uncle Sam looks after very carefully in the design of the navy vessels.

In his "Engineering Reminiscences," November *Power,* Mr. Charles J. Porter says that the firm of Smith & Coventry, Manchester, first introduced the plan of using inserted tool holders for lathe and planer work, thus saving the time of the men spent loafing in the blacksmith shop waiting for tools to be dressed. This firm also adopted the plan of grinding the tools to fixed angles, having one boy who did nothing else but collect tools, grind them while held in a suitable fixture, and return them to the men. In the same connection Mr. Porter says that in this shop he picked up the idea of the solid wrench having the sides of the jaws at an angle of 15 degrees with the handle, by which expedient it is possible to turn a hexagon nut in close quarters, as is now well known. Upon his return to the United States in the late "sixties," wrenches made on this plan were furnished with the Porter-Allen engines, and the J. H. Williams Co. soon commenced their manufacture here.

It is well known that water under pressure will leak through joints that appear (and are) perfectly tight with steam pressure. In the language of the pipe-fitter, steam pipe joints have the property of "taking up," that is, small leaks are self-sealing. Prof. Ewing calls attention to the fact that this property applies to superheated steam to a greater degree inasmuch as the presence of water of condensation is impossible, which is not the case with saturated steam. In the cylinder of a saturated steam engine in good condition there is always a certain amount of leakage past the piston and valves, represented almost entirely by the water of condensation which collects in films and slips by the closest fitting surfaces—in small quantities, it is true, but representing a vastly greater volume of steam. But with superheated steam this trouble vanishes since with a large ratio of expansion there is little or no cylinder condensation. This is not stating, however, that a whole troop of other mechanical troubles are not introduced, which are of much greater difficulty and importance.

Several years ago Mr. George Westinghouse, we believe, first called attention to the great increase of distance required for the stopping of high-speed trains after the brakes are applied, over the distance required for stopping trains running at ordinary speeds, say, 35 to 45 miles per hour. The distance required, with the same braking effect, is theoretically as the ratio of the squares of the two speeds. That is, if it requires a distance of 400 feet to bring a train running 40 miles an hour to a dead stop after the airbrakes are first applied, a distance four times as great, or 1,600 feet, would be required, theoretically, for the same train running at a speed of 80 miles an hour. Therefore we are not surprised to learn that in the high-speed tests on the Marienfelde-Zossen experimental railway the car ran fully a mile after the brakes were applied. The maximum speed was, it will be remembered, something over 130 miles per hour.

In dealing with slowly-moving mechanism, it is easy to determine by observation the exact motion of the different elements constituting the machine. At high speed this is less easy, and where cams are made use of for actuating certain parts, it is impossible to find out what happens at high speeds from observations made at low ones, since the inertia effects only become of importance when the speed is great. A method of observing the motions of rapidly-moving parts, such as, for instance, the opening and closing of the exhaust valve motion of a high-speed petrol motor was described by Professor Hospitalier at a recent meeting of the Paris Society of Civil Engineers. In principle the plan consists in illuminating the valve motion in question by flashes of intermittent light. If these flashes occur regularly at every cycle of the motor the valve gear will appear quite stationary, while if the periodicity of the flashes is slightly decreased, the motion will appear to run through its complete cycle, but at a very slow speed, and in so doing every vibration it makes will be clearly observable. An instrument specially designed for researches of the kind in question has been constructed for M. Hospitalier by Messrs. Malicet and Blin, of Paris.

In a paper read by Charles F. Burgess before the American Electrochemical Society at Niagara Falls, N. Y., September 18, 1903, he told how the passive state of iron is successfully used to permit the removal of spelter from the outside of brazed joints. Iron has the peculiar property of going into a passive state when employed as the anode in suitable electrolytes—sodium nitrate and other soluble nitrates being examples. When in the passive state the iron is no longer attacked by the anode products, the iron acting the same as an anode of platinum. This peculiar property has been only recently utilized for removing spelter, the demand for such a process having arisen with the "dip" process of brazing used in bicycle manufacture. In this process the joints of the frames are dipped into a crucible of melted spelter, covered with a suitable flux. The spelter not only enters the joint, but adheres to the exterior of the frame and has to be removed before the frame is enameled. The ordinary process is by laborious filing, but this is now being rapidly superseded by the electrolytic stripping process, the spelter being dissolved off in the bath without affecting the iron or steel frame. The process not only saves considerable labor, but avoids the danger of damaging thin tubing by file scratches, etc.

From the daily consular report No. 1802 we learn of a new armored concrete flooring manufactured in the shape of beams ready for use by three factories in Germany, three in Russia, and one in Italy, operating under the Siegwart patent; also by the Siegwart Beam Company of Lucerne, Switzerland. These beams are made hollow for the sake of lightness and generally have six iron rods ranging in size from .197 to .394 inch diameter, according to the size and span, imbedded in their walls. They have a uniform width of 9.84 inches and are made 3.5, 4.7, 5.9, 7.1, and 8.4 inches high, according to the span and load. The beams are not made singly, but in breadths of about 8 feet, which are cut up into slices before the cement has set, by means of a special machine. The hollow spaces are formed by iron cores so made that they may be contracted by turning a screw, and thus allow their easy removal after the concrete has partially hardened. The concrete is made in the proportion of one part of cement to four parts of coarse sand. In addition to being used for floors the Siegwart beams may be used for terraces, roofs, walls, pavements, etc. Being hollow they prevent excessive radiation of heat, making buildings warm in winter and cool in summer, and the hollow spaces may be used for hot air conduits if so desired.

RECORD FREIGHT RUN.

New York Central officials recently made public the running time of a freight train loaded with export cotton, which it was said holds the freight record between Montreal and New York. The train made the 435 miles between Valleyfield, Quebec, and New York in 16 hours and 20 minutes. Two hundred bales of Egyptian cotton were in store at Valleyfield, a few miles south of Montreal. They had been sold to Liverpool spinners and in order to make delivery it was necessary to get the cotton to New York within seventeen hours. One of the railroad traffic officials in speaking of this run said that it was significant in showing that the Canadian rail and ocean service was wholly inadequate in cases of emergency when certainty of delivery is important. From this it was maintained that the trunk lines are in absolutely no danger of losing their prestige to the Grand Trunk or the Canadian Pacific.—*New York Herald.*

THE MACHINIST MUST BE A SPECIALIST.

The writer was in a railroad repair shop recently when the division superintendent brought in a typewriter to be fixed—said it was out of kilter. The foreman looked at it, struck a key or two, and remarked: "I don't know much about these things." "Why," exclaimed the superintendent, "you have the reputation of being the best mechanic on the road; I thought you were just the man." The foreman turned to the speaker and said: "I am a locomotive repair machinist, and have carefully studied it for fifteen years; if you will bring me any job on a locomotive that I cannot do that any other mechanic can, I will resign, but life is too short for a man to spread himself out so thin as to attempt to be familiar with all classes of machinery. There are men who make a specialty of typewriters, as I do of locomotives. They can repair that machine in half the time, for half the money, and twice as well as I can. I would be as foolish to attempt to put new letters on that machine as the maker of typewriters would be to put a new tire on a locomotive."—*Railway and Locomotive Engineering.*

THE BAND SAW IS AN ENGLISH INVENTION.

The well-known English author of several books on wood-working machinery, Mr. M. Powis Bale, of London, takes issue with the *Timber Trades Journal* of the same city regarding the invention of the band saw, which was attributed by that publication to a Frenchman. He says:

"I notice that the invention of the band saw is attributed to M. Perin, of Paris. This is an error, as it was really the invention of an Englishman—one William Newberry, who, in 1808, patented a machine for sawing wood, in which an endless band or ribbon saw strung over two wheels was used. Owing to the difficulty, however, of obtaining saw blades that would withstand the strain put on them, the machine remained in abeyance for many years, till M. Perin, about 1855, introduced a much improved machine on which he used specially-tempered saw blades of French manufacture, and thus made the machine a practical commercial success. The early history of wood-working machinery is extremely interesting, and I would draw your attention to the marvelous patent specifications of Sir Samuel Bentham in 1791 and 1793, as they are truly remarkable examples of inventive genius, and fully illustrate the old adage, 'There is nothing new under the sun.' In these specifications the principles involved in many of the most important wood-working machines at present in use are claimed and set forth in the clearest and tersest manner, including planing machines with rotary cutters to cut on several sides of the wood at once, veneer cutting machine, horizontal saws, molding and recessing machine, bevel sawing machine, saw sharpening machine, tenon cutting by means of saws, and many kinds of rotary and boring tools. Well may the disappointed inventor say, 'Those beastly ancients have cribbed all our best ideas.'"

ELASTICITY OF CAST IRON PISTON RINGS.

A somewhat elaborate paper on cast iron for piston rings was read by Mr. C. H. Wingfield before the British Association, September 16, in which he referred to what we infer is a generally well-known fact, and that is, that cast iron is not initially elastic, but becomes so only after it has received a permanent set. That is, any ordinary piece of cast iron when placed under a bending stress for the first time, does not return to its original shape when the load is removed, but suffers a permanent change of form. After the permanent set has been given it, however, cast iron is perfectly elastic within limits. Mr. Wingfield made experiments on piston packing of the class having an inner and outer ring, the outer being turned to same diameter as the cylinder bore and the inner ring turned to a larger diameter than the bore of the outer ring. These inner rings were made 5.236 to 5.728 inches diameter, and had sections cut out so that they could be pushed into a ring gage 5.039 inches diameter, to determine the amount of permanent set and the "follow" (reduction in diameter) of the ring. He was surprised to find that a ring 5.236 inches diameter having a section 1½ inches cut out, could be bent until the ends met without fracture and that they would spring back to within ⅜ inch of their original position an indefinite number of times without taking any further permanent set. He found that some time was required of the rings pushed within the ring gage before the maximum permanent set was acquired. For example, the follow in the case of a ring 5.433 inches diameter was .396 inch before being pressed into the ring; after being in the ring one minute, it was .291 inch; after fifteen minutes, .287; after forty minutes, .280 inch; and after forty-eight hours, .275 inch.

In this connection it may be mentioned as a matter of interest and possibly of news to some, that cast-iron packing rings often show a wonderful increase of flexibility (not elasticity) with use. The editor has repeatedly tested certain old cast-iron packing rings used in locomotive cylinders, say 20 inches diameter, by placing a foot on one end and pulling the other end of the ring upward in a direction parallel to its axis, to the level of his shoulder—he is not a short man—before it fractured. In such cases the observers would almost invariably declare that the ring must be made of wrought iron so great was its flexibility, but such was not the case in any instance, as was easily discerned from appearance of the fractures.

MOUSE POWER.

In these days of 12,000-horse power stationary steam engines, 100,000-horse power central stations, and 1,000,000-horse power Niagara development (near prospective), it is somewhat difficult to appreciate the scarcity less than one hundred years ago and the shifts made to gain that which more than anything else has made present civilization possible—power. The following remarkable item published by the *Scotsmen* and copied by the *Tradesman*, to whom we are indebted, may be an exaggeration, but it undoubtedly records one of the schemes seriously contemplated for operating machinery:

"About the year 1820 this gentleman actually erected a small mill at Dunfermline for the manufacture of thread—a mill worked entirely by mice. It was while visiting Perth prison in 1812 that Mr. Hatton first conceived this remarkable idea of utilizing mice power. In an old pamphlet of the time, 'The Curiosity Coffee Room,' he gave an account of the way in which the idea dawned on him. 'In the summer of the year 1812,' he wrote, 'I had occasion to be in Perth, and, when inspecting the toys and trinkets that were manufactured by the French prisoners in the depot there, my attention was involuntarily attracted by a little toy house with a wheel in the gable of it that was running rapidly round, impelled by the insignificant gravity of a common house mouse. For a shilling, I purchased house, mouse and wheel. Inclosing it in a handkerchief, on my journey homeward I was compelled to contemplate its favorite amusement. But how to apply half-ounce power, which is the weight of a mouse, to a useful purpose was a difficulty. At length the manufacturing of sewing thread seemed the most practicable.' Mr. Hatton had one mouse that ran the amazing distance of eighteen miles a day, but he proved than an ordinary mouse could run ten and one-half miles on an average. A half-penny's worth of oatmeal was sufficient for its support for thirty-five days, during which it ran 736 miles. He had actually two mice constantly employed in the making of sewing thread for more than a year. The mouse thread mill was so constructed that the common house mouse was enabled to make atonement to society for past offenses by twisting, twining and reeling from 100 to 120 threads a day, Sundays not excepted. To perform this task, the little pedestrian had to run ten and one-half miles, and this journey it performed with ease every day. A half-penny's worth of oatmeal served one of these thread mill culprits for the long period of five weeks. In that time it made 3,350 threads of twenty-five inches, and as a penny was paid to women for every hank made in the ordinary way, the mouse, at that rate, earned 5 pence a day, or 7 shillings and 6 pence a year. Taking 6 pence off for board and allowing 1 shilling for machinery, there was a clear yearly profit from each mouse of 6 shillings. Mr. Hatton firmly intended to apply for the loan of the old empty cathedral in Dunfermline, which would have held, he calculated, 10,000 mouse mills, sufficient room being left for keepers and some hundreds of spectators. Death, however, overtook the inventor before his marvelous project could be carried out."

EXPERIMENTS TO DETERMINE THE AIR FRICTION OF DISKS.

Abstract of Paper read by William Odell before the British Association at Southport, September, 1903. Electrical Review (London), September 25, 1903, p. 490.

The experiments were made with the object of finding a convenient method of determining the power wasted by air friction or windage of flywheels, armatures, etc. They were made with paper disks mounted on the shaft of an electric motor. The excitation being kept constant, the torque was proportional to the current. Thus the extra current required to keep up the speed after the disk was fixed on the shaft, gave the power absorbed by air friction.

There was found to be an angular speed for each disk above which the torque was accurately proportional to about 2.5 power of the speed. This critical speed appeared to vary inversely as the square of the diameter. Below it the law followed was of a lower degree; but owing to the multiplication of errors of measurement no definite conclusion as to its exact nature was arrived at.

As the three disks originally tried gave uncertain results as to the effects of size, a much larger one, nearly 4 feet in diameter, was also tried; and as a result of all the experiments it was concluded that the torque varies as about the 5.5 power of the diameter.

To give an idea of the amount of power thus absorbed, it may be stated that a disk of 47 inches required 1-10 horse power to keep up a constant speed of 500 revolutions per minute, and that if the above law holds, a 9-foot disk would absorb 10 horse power at the same speed.

STANDARDIZING MACHINE TOOL PARTS.

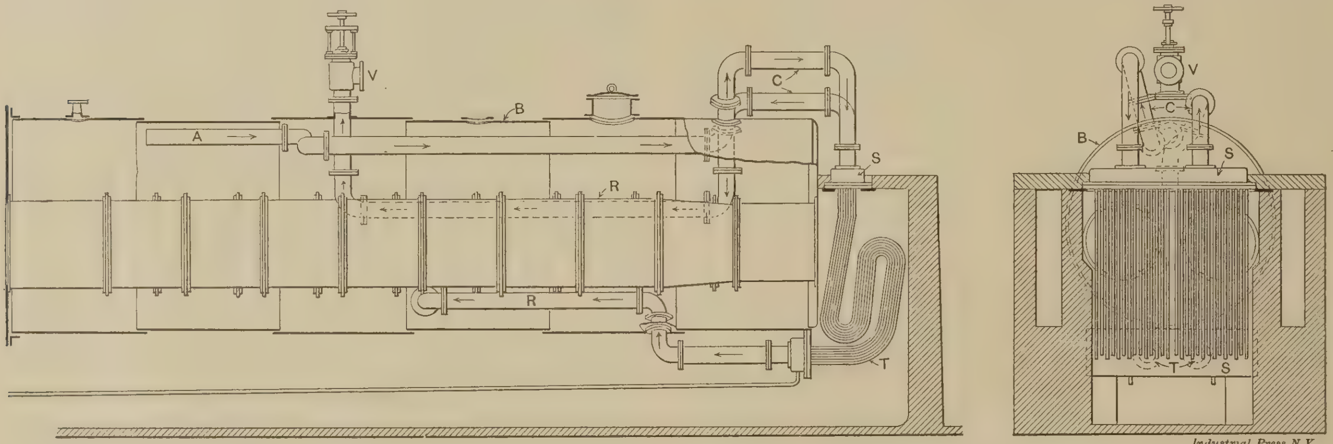
Extract from Paper read by Mr. William Lodge before the New York Meeting of the National Machine Tool Builders' Association, November 10, 1903.

It would be to the interest of this association, if it could possibly be brought about, that some standard be adopted. Why may not all manufacturers of machine tools have the same size of general bearings, the same size of nose for the lathe spindles for the different sizes of lathes, so that our customers may find it easy to transfer faceplates, chucks, and tools from one machine to another, irrespective of who may have been the manufacturer. If this matter can be brought about we shall be the first country to have adopted a uniformity. This would be a most important matter, not only to ourselves but to the men to whom we sell, and it would, at least, have the effect in foreign countries of securing preference for American tools, because of their interchangeability at certain points and because of their uniformity in weight and power. I do not advocate uniformity in the design of the machines throughout, and I know it is utterly impossible to secure uniformity in the quality of the work put into the machines but it will be of great assistance to incorporate the features mentioned wherever possible. If the salesmen for the different houses were attempting to get trade in either Europe, Asia or Africa, and the statement could be made that chucks and tools could be interchanged from one machine to another, no matter who the maker was, it would be bound to result in a preference for American goods. As we are all likely to have to make new designs, it would be well if it were possible to bring about this interchangeability. Would it not also be well to establish uniform widths and diameters for countershaft pulleys and for the countershaft itself, because these vary so much as to appear ridiculous at times?

APPLICATION OF AIR BRAKES TO THE TRUCKS OF LOCOMOTIVES ON THE STATE RAILWAY OF BELGIUM.

Bulletin of the Railway Congress, June, 1903, p. 589.

The management of the State railways of Belgium have realized the advantages to be obtained by the application of brake-shoes to the wheels of bogie trucks on locomotives. Heretofore, shoes operated by the Westinghouse brake have only been applied to the driving wheels of locomotives. An arrangement designed by the motive power department has just been tested on a four-coupled engine. Several months of service have shown that this supplementary braking on the locomotives makes it possible to secure a very material reduction in the distances needed in which to stop trains. Further tests are in progress in order to determine the time advantage that can thus be obtained at different speeds upon the several lines of the State railways. G. L. F.



Industrial Press, N.Y.

Elevation and End View of a Boiler Fitted with McPhail & Simpsons Superheater.

SUPERHEATED STEAM FOR STEAM ENGINES.

Cassier's Magazine, November, 1903, p. 18.

The weight of steam used per indicated horse power is materially less when the steam is superheated than when saturated steam of the same pressure is used. If the consumption be taken as 100 for saturated steam, it will be roughly as given in the following table, when superheated. In other words, each 50 deg. of superheat in a reciprocating engine reduces the former consumption by about 10 per cent., and by 5 per cent. in the case of a turbine, which is in inverse proportion to the volume of the steam or to the absolute temperature. This must be taken only as a rough approximation, but it nevertheless, agrees tolerably well with the results of experiment.

Superheat at the Engine.	Consumption.	
	Turbine.	Reciprocating Engine.
...	100	100
50° F.	95	90
100° F.	90	81
150° F.	86	73
200° F.	81	66
250° F.	77	60
300° F.	73	53
350° F.	69	48
400° F.	66	44

This economy is largely due to the fact that the temperature of superheated steam is considerably above its saturation or condensing point; consequently when it enters a cylinder cooler than itself and its temperature is thereby reduced, the usual cylinder condensation does not take place until the temperature is reduced to that of saturation. Cylinder condensation is, therefore, largely reduced, and if the superheat be sufficiently great, the condensation may be entirely overcome.

The decreased steam consumption is due also to the fact that the volume of the steam is increased by the superheating in amount almost proportional to the absolute temperatures before and after superheating. Since its capacity for doing work at any given pressure varies almost directly as its volume, it follows that a given weight of steam has a greater capacity for doing work when occupying a greater volume than before; consequently a smaller weight of steam is required to do a given amount of work. A minor advantage, apart from the question of economy, is that the steam supplied to the engine is perfectly dry when it is superheated, and the dangers of priming are thus avoided. Now that so many water-tube boilers are used which nearly always prime badly when forced, the question of getting dry steam, especially with high speed engines, is becoming one of very great importance.

The disadvantages of highly superheated steam are that the steam not only supplies no water of condensation to lubricate the rubbing surfaces of the valves and cylinders, but it decomposes many of the oils that are fed into the cylinder for lubricating purposes; hence the valve faces, cylinders, and pistons are liable to become badly scored; also, the gland packing not infrequently is burnt or melted out.

It must, however, be remembered that these are troubles which arise only when high degrees of superheat are adopted. Thus, in order to get some of the benefit to be derived from superheating without experiencing the troubles mentioned above, it is necessary, under ordinary circumstances for power purposes, to use only very moderate degrees of superheat, say 100 degs. F. This, however, is a difficult matter to accomplish, unless a special regulator or modifier be used to keep the superheat within any given limits. With many of the superheaters in common use, it will vary a hundred degrees or more in a very few minutes unless it be very carefully watched.

When considering the disadvantages of superheating, the fact must not be overlooked that in a great many cases the superheater tubes have been known to burn out. The burning away of the superheater tubes has occurred in most cases where flooding arrangements have been used, as a deal of scum and scale is carried into the tubes with the water, and if the flooding is frequently indulged in, the tubes, in time, get choked up, with the inevitable result that they burn out, thereby making the wear and tear an important item, as compared with the reduced coal bill. Again, it must not be forgotten that superheaters which are not furnished with a device for regulating the temperature become a source of trouble and expense if neglected.

The McPhail & Simpsons superheater, says the writer, Mr. John Goodman, has been designed with the express purpose of overcoming most of the disadvantages enumerated above, primarily by producing superheated steam at a controlled and constant temperature, and, further, by utilizing more of the heat of the escaping gases than can be accomplished by ordinary economizers and feed heaters.

The apparatus in one style consists of superheater tubes *T* connected together by top and bottom boxes *S*, which are divided into two compartments; connections to and from the superheater *C*; radiating pipes in the water space of the boiler *R*; and anti-priming pipe *A*. The steam passes from the anti-priming pipe *A* to the connecting pipes *C*, and thence through the first compartment of the top box and through the first nest of superheater tubes to the first compartment of the bottom box and into the radiating pipes *R*, which are placed in the water space of the boiler below the fire flues. It then passes out of the boiler again into the second compartment of the bottom box and up through the second nest of superheater tubes to the second compartment of the top box, and, by connections *C*, into the radiating pipes *R*, placed in the water space above the fire flues, and leaving the boiler at the stop valve. It will be observed that the steam is superheated twice and carried into the boiler twice, where it gives up a part of its surcharged heat each time to the water in the boiler, thereby assisting evaporation, the steam leaving the stop valve at a controlled and constant temperature. This apparatus is constructed of steel throughout. The superheater tubes are of cold, solid-drawn steel. The tube-plate is of rolled mild steel, 1¾ inches thick, and the boxes are of rolled mild steel plate, dished.

MONEY VALUE OF TRAINING.

Abstract of Paper read by Mr. James M. Dodge before the Williamsom Trade School of Philadelphia, March 1903.
From St. Nicholas Magazine.

When the trade guilds were in active existence in England and this country up to 1850 they gave thorough instruction to apprentices in the various crafts. A shoemaker's apprentice, besides learning how to make boots and shoes, might also learn to tan skins, make thread and wax, carve his lasts, build his own furniture, and, in fact, produce from the raw material everything required for the prosecution of his calling. But with the decline of the guilds, due to the introduction of labor-saving machinery, the opportunities for learning a trade dwindled away. Generally speaking, there are now few opportunities for a young man to acquire the trade of a machinist in the shops of this country. In the first place the establishments are frequently so large that an individual is entirely lost sight of. If he does the special line of work assigned him, he is allowed to remain in one place indefinitely. Frequently the training of years in one shop will not enable a man to get employment at good wages in another. The trade unions have not filled the place of the guilds in this respect; they pay no attention to the training of apprentices or otherwise recognize them, beyond limiting so far as possible the number that shall be employed. The attitude of the trade unions to apprentices is purely "negative."

In years gone by the apprentice was trained in a large range of duty incident to the work of a machinist, in a broad sense; but there is no longer in the machinist trade true apprenticeship. We believe that a month in a good trade school is worth a year in a large shop, so far as the matter of training in first principles is concerned. Of trade schools locally we have some splendid examples—the Drexel Institute, the Williamson Trade School, the manual training school, and others. But scattered over the country are schools of this character which undoubtedly will grow more rapidly than any educational institutions of the past.

It has been said that a three years' course in a trade school, in which an average of but a few hours a day is devoted to actual manual work, can in no way compare with three years' time spent in actual work in a shop. This is felt to be a popular error. In shop work a man may spend months in repetition of the same task, to no ultimate advantage to the worker. Instead of his skill being quickened it is dulled. He very quickly acquires the skill which is unconscious in its operation, and, like the old lady with her knitting needle, he can talk to a fellow-workman or think and dream about far distant places and matter without in any way lessening the rate of production. In fact, sometimes his pace might be actually quickened by some mental emotion having an exciting effect upon his nervous organization, in the same way that the old lady, in chatting with her friends, will knit fast or slow in harmony with the dullness or animation of the conversation. It is quite obvious that repetitive routine work is not desirable for a young man of natural ambition and aptitude. In the trade school he escapes routine, but is instructed in the underlying principles of his work, and does enough manual labor to familiarize himself with the various tools required and tend to prove the correctness of the theories in which he has been instructed.

The trade school training is one decidedly tending toward individualism. Its boys, as a rule, do not come from the wealthier classes. There is earnestness of purpose, and the records show that the percentage of failure to pass satisfactorily through the course is exceedingly small. In opposition to this, it not infrequently happens in our larger universities of learning that less than one-half of those entering the freshman classes graduate. Not more than 5 per cent. of the boys entering the trade schools fail to complete the course satisfactorily, and the tasks set are no less exacting than those in our large colleges and universities. This may be attributed to the fact that no boy enters a trade school without a positive determination to complete the course and be thankful for the opportunity. None are forced to go through the ambition of their parents, because, as a rule, the decision to send a boy to one of the trade schools is a serious sacrifice on the part of his family. In the trade school the boy is impressed with the idea that his first day there is the beginning of his career. In our larger institutions the day after commencement is looked upon as the beginning of the career. This is a very important distinction. Again, in entering the trade school a boy has already made up his mind what his life work is to be. In the majority of cases, boys entering our universities have no clearly defined idea of their future work after graduation. As a result, the trade school boy can directly apply the training he has received toward increasing his value to his employer and himself.

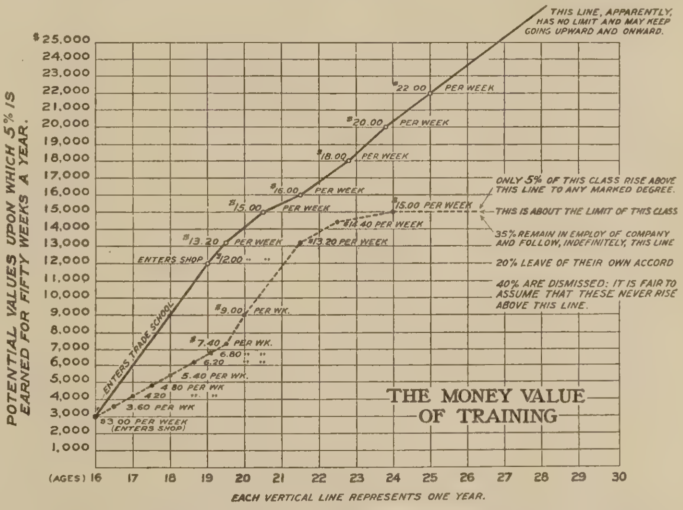


Diagram giving Curves showing the Comparative Value of Trade-school and Shop-trained Boys. Curves Plotted from Records of two Groups of twenty-four Boys each.

Now for a comparison of values of the trade school boy and the shop trained boy. The boy of sixteen who is tired of going to the day school thinks he will learn a trade. His father does not oppose his leaving school perhaps because he thinks, from his own experience, that the boy has enough "schooling." The boy naturally selects some trade because he sees all about him the relatively affluent position of the men working at trades and those who are simply laborers. Say he obtains employment in a machine shop where he will receive about $3 per week, this being, we will say, $150 per year, or 5 per cent. on $3,000. The dotted curve in the diagram shows his probable money value up to 26 years, beyond which age only about 5 per cent. increase their earning capacity. The full line shows the probable earning capacity of the trade school boy, and its upward tendency apparently has no limit. This diagram was plotted from two groups of twenty-four boys each, or forty-eight in all, one-half entering the trade school and the others going directly into the shop.

The untrained boy in three years has increased his earning power from $3 per week to $6.80, and the Williamson School boy in traversing the line between his entrance and graduation crosses the $6.80 line after he has been in the school a year and three months. In other words, he has gained almost two years on the boy who entered the shop with the idea that school training was an unnecessary waste of time. It is quite evident, therefore, that time has been lost, and not gained, by entering the shop without training. Roughly, this holds true indefinitely. While the two lines run along parallel or substantially so, say for the next four or five years, the time element is always in favor of the trained boy, and that in a very few years he is leaving his less fortunate brother well to the rear.

From the age of 20 to 21½, or for 18 months, if the untrained boy continues to do his work well, it will be seen, by reference to the chart, that his line has continued running more toward the vertical than it did from the time he was 16 until he was 19½. Now the experience which he received during the formative period is beginning to make itself very manifest. He becomes more useful as an all-around man, and his rate is increased to $13.20 per week. Carried back to the left, we find that his potential value is working upward toward $14,000. A year later, or taking the age 22½, his wage has been increased to $14.40 per week. Again we see his potential value has gone up beyond $14,000. For the next 18 months he continues in substantially the same line, and at 24 years of age is earning $15 per week, and his potential value is $15,000. In other words, he has increased his potential value $12,000, and draws the interest on his investment in instalments once a week, and is earning 5 per cent. on his accumulated value.

We find that only 5 per cent. of this class rise above this line to any marked degree. Thirty-five per cent. remain in the employ of the company and follow the line indefinitely. Twenty per cent. leave of their own accord, but with good records behind them (so that probably the same statistics would apply to them also—that is, 5 per cent. of them may rise above the line and 35 per cent. of them follow the line in other establishments). Forty per cent. are dismissed, and it is fair to assume that these never rise above the line. They are not dismissed at the age of 26, but fall by the wayside, unable to keep pace with the march of progress.

We will now turn to the group who have entered the trade school. Starting again at the potential value of $3,000 for the boys of 16 years of age, we will follow the course of an individual, representing the average of his companions. The first noticeable thing is that for three years, starting from the age of 16 and terminating on the line representing 19 years, he is in school; and instead of having his wage-rate dotted along at intervals of 6 months, as in the case of the boy entering a shop without the trade school training, we find no rates at all, and we feel justified in making this line perfectly straight, with the first money entry made upon it at the time of his graduation, at the age of 19, and entering upon his employment. We now find a most interesting state of affairs. He is employed at the rate of $12 per week, this representing a potential value of $12,000, or an increase *during his school term* of $9,000, or an average of $3,000 per annum. During the same term the untrained boy has reached a potential of $7,000 at the same age; in other words, the trained boy has a $5,000 start at the same age. Again, the untrained boy's line crosses the $12,000 potential line at a point which indicates that he is 21 years of age. In other words, the trained boy has $5,000 advantage at the same age, and has two years running start on the boy who has not had the same training. Now, what does he do in the next two years? To follow along his career, it will be noted that in six months his rate has been increased to $13.20 per week. One year later, or at the age of 20½, he has reached $15 per week. The untrained man is now 24 years old and earning the same wage, but his line of progress is running more nearly parallel with the horizontal line than that of the trained man. Six months later, at the age of 21½, they part company quite decidedly, the untrained man's line running off horizontally to the right, whereas the line of the trained man is progressing onward and upward, at substantially the same angle it has shown since the time of his entrance to the trade school. Why is it possible for these two men thus to part company? It is because the untrained man can increase his rate only by remaining as a working machinist in a shop. The trained man has substantially mastered all that the untrained man has, so far as his actual labor is concerned, but he has within him other possibilities. He can now apply in a combined manner his theoretical and his practical training, becoming a leading man, possibly a foreman or a draftsman. It is now that this, his better knowledge, coupled with his intellectual improvement, makes itself most manifest. His rate at the age of 21½ is $16 per week; his potential value $16,000. Fourteen months later we find him earning $18 per week; ten months later $20 per week; and in another year, or at the age of 25, he is earning $22 per week—a rate practically unattainable by the untrained man. Five per cent. of the untrained—those having decided genius and a faculty of improving their minds and increasing their theoretical knowledge, courage enough to take courses in the correspondence schools or obtain instruction in the evenings—rise to his class, and it is not impossible that in very rare instances would do as well through their future life. A trained man at 25 years of age has a potential value of $22,000, or in nine years he has increased his value $19,000, or at the rate of $2,100 per annum, as compared with $1,300 per annum for the untrained man, and with this manifest additional advantage over the untrained man—that his line has no limitation, so far as we can see.

THEORETICAL EFFICIENCY OF WORM GEARING AND TESTS OF SAME.

Page's Magazine, November, 1903, p. 428.

Worm gearing differs from most other forms—belting, spur gearing, etc., in that it requires very accurate design and manufacture to be efficient. It has always been more or less under a cloud on account of bad examples of the gear which have been set to work. Several firms, however, amongst whom may be mentioned the Oerlikon Company have consistently stood by the gear, and by turning out good work have helped materially to win for it the position it now holds as one of the best mediums for electric motor driving. One of the distinct advantages of the gear is its *noiselessness*, and this undoubtedly has a money value. As there still exists a certain amount of mistrust as to the efficiency, it may be of interest to give some figures obtained by the Oerlikon Company.

TABLE GIVING THEORETICAL EFFICIENCY OF WORM GEARING.

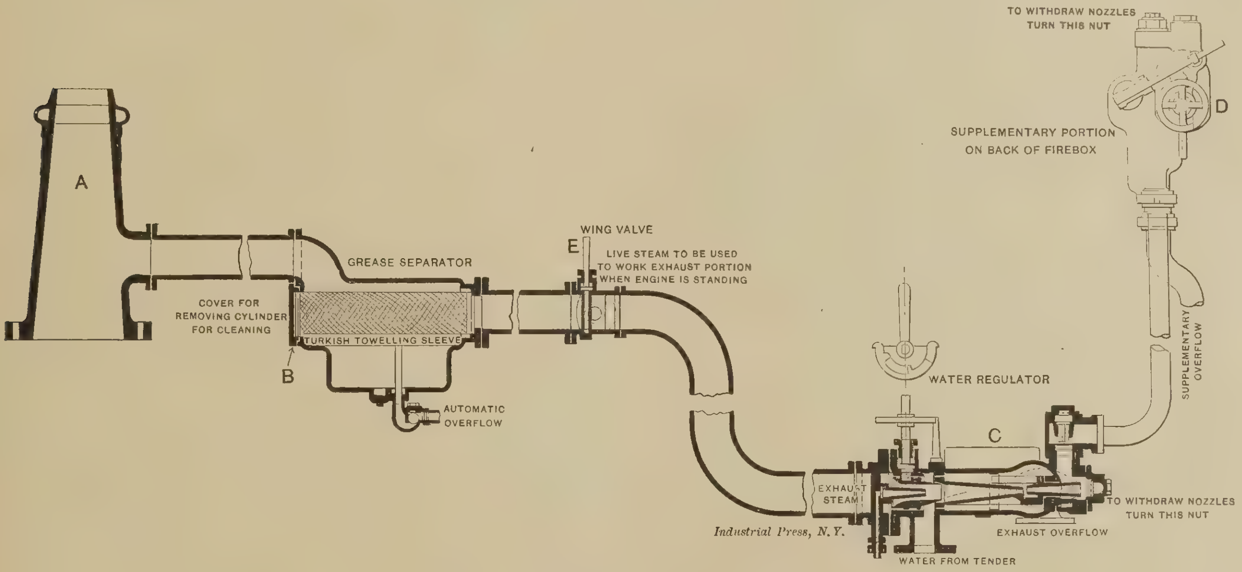
Coefficient of Friction.	ANGLE OF INCLINATION.								
	5 deg.	10 deg.	15 deg	20 deg.	25 deg.	30 deg.	35 deg.	40 deg	45 deg
0.01	89.7	94.5	96.1	97.0	97.4	97.7	97.9	98.0	98.0
0.02	81.3	89.5	92.6	94.1	95.0	95.5	95.9	96.0	96.1
0.03	74.3	85.0	89.2	91.4	92.7	93.4	93.9	94.1	94.2
0.04	68.4	80.9	86.1	88.8	90.4	91.4	92.0	92.2	92.3
0.05	63.4	77.2	83.1	86.3	88.2	89.4	90.1	90.4	90.5
0.06	59.0	73.8	80.4	84.0	86.1	87.5	88.2	88.6	88.7
0.07	55.2	70.7	77.8	81.7	84.1	85.6	86.4	86.9	86.9
0.08	51.9	67.8	75.4	79.6	82.2	83.8	84.7	85.2	85.2
0.09	48.9	65.2	73.1	77.6	80.3	82.0	83.0	83.5	83.5
0.10	46.3	62.7	70.9	75.6	78.5	80.3	81.4	81.9	81.8

The efficiency increases with the angle of inclination up to a certain point, and with the smallness of the coefficient of friction, and knowing these two factors it is possible to calculate the theoretical efficiency as shown in the table. Experience shows that for larger angles of inclination than 25 degrees to 30 degrees the efficiency increases very little, especially if the coefficient of friction is small, and this fact is of importance in practice, because, for reasons of gear ratio and conditions of a constructive nature an angle greater than 30 degrees cannot be employed. The coefficient of friction increases with the load and diminishes to a certain extent with increase of speed. Besides the friction between the worm and the wheel teeth there is also the friction of the spindle bearings and the ball bearings for taking the axial thrust. To obtain the best results, there must be very careful choice of dimensions of teeth, of the stress between them, and the angle of inclination. Also the most accurate workmanship in which the hardening of the worms without any consequent retouching, forms an important part. To show what can be done, the following are the results of a test with an Oerlikon worm gear for a colliery winding engine: The motor gave 30 brake horse power to 40 brake horse power at 780 revolutions. The normal load was 25 brake horse power, but at starting it can develop 40 brake horse power. The worm gear ratio is 13.6 to 1, the helicoidal bronze wheel having 68 teeth on a pitch circle of 7.283 inches and the worm 5 threads. The power required at no load for the whole of the gear was 520 watts, corresponding to 2.8 per cent. of the normal. The efficiency at one-third normal load gave 90 per cent., at full load 94½, and at 50 per cent. overload 93 per cent. The efficiency of the *worm and wheel alone* is higher, and knowing the no load power, it calculates out at 97½ per cent. According to the above table of theoretical efficiencies this gives the coefficient of friction as 0.01. To obtain a reduction of 13.6 to 1 with spur gear would have necessitated two pinions and two wheels with their spindles and bearings, and if the bearing friction was taken into consideration the efficiency of such gearing would certainly not have reached the above-mentioned figure of 94½ per cent. at full load.

LOCOMOTIVE INJECTOR OPERATED BY EXHAUST STEAM

Fielden's Magazine, November, 1903, p. 422.

In locomotive feed-water injection it is highly desirable that the temperature of delivery be the highest degree attainable at which the injector will work without breaking. If this heat can be abstracted from the exhaust without increasing the back pressure it is apparent that an economy will result. While the ordinary type of high-pressure steam injector will not work satisfactorily when the supply water in the tender is even moderately warm, the exhaust steam injector made by Davies & Metcalfe, Manchester, it is claimed, in connection with the supplementary apparatus, will deliver water to the boiler at a temperature of 270 degrees F. Thus, while it is not feasible to utilize the heat of the exhaust to warm the supply water with the ordinary injector to any extent, it is possible with the exhaust steam injector to use a considerable portion of it and to deliver the water in a large volume at so high a temperature that it cannot have a bad effect upon the plates or tubes.


TO WITHDRAW NOZZLES TURN THIS NUT
D
SUPPLEMENTARY PORTION ON BACK OF FIREBOX
A
GREASE SEPARATOR
COVER FOR REMOVING CYLINDER FOR CLEANING
TURKISH TOWELLING SLEEVE
B
AUTOMATIC OVERFLOW
WING VALVE
E
LIVE STEAM TO BE USED TO WORK EXHAUST PORTION WHEN ENGINE IS STANDING
WATER REGULATOR
SUPPLEMENTARY OVERFLOW
C
EXHAUST STEAM
TO WITHDRAW NOZZLES TURN THIS NUT
EXHAUST OVERFLOW
WATER FROM TENDER

Industrial Press, N. Y.

British Locomotive Exhaust Steam Injector.

The exhaust pipe, *A*, is tapped near its base for the steam supply. A grease extractor, *B*, is provided to remove the oil and water of condensation. From thence the steam passes into the exhaust injector, *C*, which, of course, is of the non-lifting type, being located beneath the foot-plate. But because of its weak forcing power it is necessary to provide the supplementary injector, *D*, to take the water from the exhaust injector—which it does at a temperature of 200 degrees and a pressure of about 70 pounds—and deliver it to the boiler, which it does at a temperature of 270 degrees as stated. A wing valve, *E*, is provided in the exhaust pipe between the oil separator and the first injector which may be closed, and a live steam valve opened to work the injector when the locomotive is standing idle.

It is stated that the firm making these injectors have applied a large number of them to locomotives on various English railways, and that they are working successfully.

ELECTRICITY IN MANUFACTURING PLANTS.

Abstract of Paper by Walter M. McFarland before the Society of Naval Architects and Marine Engineers.

In considering the relative merits of alternating and direct-current for motor driving, it is the writer's opinion that if the induction motor had been the first to enter the field there probably would have been no room for argument, because its merits are so great that there would have been little incentive to develop anything else. It happened, however, that although alternating current was the first, as it is the natural product of any machine without special commutating devices, it was some time before a commercially practicable alternating current motor appeared, and the direct current motor, being first in the field and being undoubtedly meritorious, acquired the vogue which always comes to that with which people are familiar.

Mechanically the induction motor appeals at once to every practical man as the better device. The coils of wire are entirely stationary, while the rotating part consists of disks of sheet steel enclosed by massive composition end rings, which latter are connected by stout bars of copper bedded in slots in the steel sheets. The direct current motor, on the contrary, has its coils movable as well as stationary, and, while these do not often give trouble, they are not so simple and mechanical as the rotating part of an induction motor. The direct current motor has an additional feature which is entirely absent in the alternating current motor—the commutator and brush holder. These are the parts requiring most attention and the ones most liable to give trouble, although the modern methods of design and manufacture have reduced this to a minimum. The efficiency of the induction motor is fully equal to that of the direct current motor and indeed is slightly better over most of its range of capacity.

Thus far it might seem that everything is so greatly in favor of the induction motor that there could be no room for choice; but this type has one defect, namely, it is a constant speed motor, and many of the foremost advocates of individual tool driving want a motor whose speed can be varied through a wide range. While it is entirely possible to make an induction motor whose speed can be varied, the extreme simplicity of the first type is lost on account of the slip rings, which are used to enable the variable speed to be obtained by throwing resistance into the circuit. These, while not so liable to derangement as the commutator of a direct current machine, do add a slight additional complication. Before going on to explain some of the different methods by which variable speed is obtained with direct current motors, it may be mentioned that in the New York Shipbuilding Company and also in the steam engineering plant at the Brooklyn Navy Yard, the simplest type of induction motor is used, and the variable speed is obtained by means of belts and cone pulleys. In the opinion of the writer this method is entirely satisfactory and gives an adequate range of speeds with extreme simplicity.

It may be well to mention, in speaking of direct current motors, that apart from crane service, the type of motor almost universally used in industrial plants is the shunt motor, so called because the field circuit is a shunt from that of the armature. The shunt motor is inherently self-regulating, and within moderate limits the speed remains constant without regard to the load coming upon it. One of the simplest methods of varying the speed is by varying the field strength, which can be done by introducing a suitable rheostat in the field circuit, and as only a small portion of the current goes through this circuit anyhow, the loss is immaterial. The speed can also be varied by introducing resistance in the armature circuit to cut down the E. M. F. acting upon the armature, but this is objectionable on account of the large amount of energy wasted as heat in the resistance.

Another method which has been used with decided success and simplicity is the three-wire system from a single generator in connection with field regulation, which enables the speed of the motor to be varied sufficiently to meet all practical purposes. The three-wire system is obtained by utilizing a special generator somewhat resembling a rotary converter; that is, in addition to the brushes and commutator furnishing direct current, leads are brought out from the armature winding to two or more slip rings placed upon the armature shaft. From these slip rings alternating current is taken, and if this is passed through an auto-transformer, and a lead is tapped from the middle of the transformer coil, this lead will always have a potential midway between that of the terminals on the direct side of the machine, thus securing at the motor two voltages, one equal to twice the other. By field regulation the speed can be varied through a ratio of about one to three, so that with this variation combined with the two voltages of the three-wire system we get a range of six speeds, which, in general, will be amply sufficient.

Another system, known as the multi-voltage system, has also been used to some extent with direct current motors, consisting of a number of circuits working at different voltages. Suppose that, commencing with a negative wire, the voltage rises to 60 at the second wire, 140 at the third, and 250 at the fourth, thus giving intervals of 60, 80 and 110 volts. It is obvious that we can get any of the three voltages by the intervals, and by varying the wires we can get in all six voltages. If the field of the motor is constantly excited at, say, 250 volts, the several voltages applied to the armature will give as many different speeds, and the gaps between may be filled in by slightly varying the field excitation. The objection to this system is the complication of the generating apparatus and of the wiring.

Still another system is that called after the name of its inventor, the Ward-Leonard system, which depends upon supplying a current of varying voltage to the motor by varying the field strength of the generator, the field of the motor being constantly excited from an independent constant potential circuit. This is the system employed for turret turning on board naval vessels, where it has worked very successfully, and it was described in detail some years ago in a paper before the Society, so that we need not go into it further here. It will be seen that the objection to this system is its enormous complication when attempting to apply it to so large a number of motors as would be found in a manufacturing establishment.

An advantage of the induction motor is that from its construction there is no danger from a short circuit, because the bars in the rotating part are purposely short-circuited. Further, this motor will stand being brought to a full stop for a moment with the full current upon it without any resulting damage, while such an occurrence with a direct current motor would certainly burn out the insulation, if not doing still greater damage. As a result of this it is not necessary to fit circuit breakers or fuses to take care of these motors. In the small sizes the motor can be started up by simply closing the circuit by means of an ordinary switch, and in the larger sizes practically the same thing is done, as a two-throw switch is used in connection with an auto-starter, which is simply a small transformer arranged to give half the line voltage in starting up. The object is not so much the protection of the motor itself as to avoid the demand for a large amount of current from the generating system, as the starting current without the transformer would be somewhat more than twice full-load current. In the case of the direct current motor it is, of course, necessary to start through the rheostat, so that the full voltage only comes on when the motor is up to speed.

In regard to individual and group driving some engineers go so far as to say that they would have a motor for each tool, even if it involved going to sizes as small as one-quarter horse power, but the writer is inclined to believe that the judgment of more conservative engineers is favorable to individual driving where the power required will be, say, from five to ten horse power and upwards, and for group driving where the individual tools would require less than those amounts. In any large plant there are numerous small tools, such as drill presses, screw-cutting machines, light lathes, etc., which are in any case located together, and where it is perfectly easy to drive them as a group. The average power required for such a group will be quite uniform, and when they are group driven a moderate sized motor, with its relatively high efficiency, can be used with a fairly steady load, thus contributing to the efficiency of the general system, as well as of the particular group, and materially reducing the first cost of the installation.

ACETONE AS AN ABSORBENT OF ACETYLENE GAS UNDER PRESSURE.

Extract from Paper read by Mr. E. G. Fisher before the International Acetylene Association at Chicago.

In 1896 Messrs. Claude and Hess, two French engineers, conceived the idea of utilizing some liquid as a solvent of acetylene, and after many experiments discovered that acetone (a limpid, mobile liquid, with an agreeable odor and burning taste, produced by the destructive distillation of acetates, and procured on a large scale from the aqueous liquid obtained in the dry distillation of wood) has the property of absorbing many times its volume of acetylene gas. This property varies greatly with the pressure and temperature under which the acetylene is applied; the acetone will again release the gas absorbed under pressure, when the pressure is removed. Acetylene dissolved in acetone is inexplosive, as has been shown by Messrs. Berthelot and Vielle, French chemists. It is an inert liquid, so that if an explosion be intentionally produced in the compressed gas outside or above the solution, the solution would not be affected thereby. Thus, if a red-hot wire were inserted into a tank containing acetylene dissolved in acetone, under a pressure of 240 pounds per square inch, the small quantity of gas that exists above the liquid would explode, but the liquid would not be influenced in the least. This was a long stride in the direction of safely transporting acetylene, but absolute safety is demanded in a gas-lighting system, especially for transportation, and it was Edward Fouche, another Frenchman, who conceived the idea of packing the gas cylinders with an absorbent or porous material, thereby filling the entire air space—except, of course, the small cells in the porous brick or asbestos—then introducing sufficient acetone into the tank to moisten the cell walls of the porous brick or asbestos. This has been proved to make an absolutely safe structure for storing and transporting acetylene in small or large quantities.

Acetylene gas absorbed in acetone is now being safely and efficiently used for railway car lighting, having decided advantages over the Pintsch gas system both in efficiency and in manufacture. The ability to transport acetylene safely while under heavy pressure gives the world the use of an illuminant unequaled in brilliancy by any save the electric arc lamp.

ADJUSTABLE DIE HEAD AND METHOD FOR MAKING THREADERS FOR USE IN SAME.

JOSEPH M. STABEL.

Economical thread cutting and the production of the tools for accomplishing the same, form a very important item in many factories, especially where several hundred sizes of threads are used, so that to make a solid tap for each size would be very expensive. The tools and method here described, while by no means inexpensive in the first cost, will, when once brought into use on such work, produce a great saving over the cost of making solid tools for each size of thread, and the cutting tools, or threaders, when worn out may be renewed at a very small expense. Another advantage of this method is that found in the fact that many shops use quite an assortment of different styles of threads, and to keep each one standard, not only as to size, but as to its form, is often a difficult matter. With this system a master hob is demanded for each style of thread, such as, V, Whitworth, square, 29-degree, 45-degree, and U. S. Standard. Such a hob will, with with proper care, last a lifetime, and will insure all of the different styles being kept to their proper form, which is a very essential point in thread cutting.

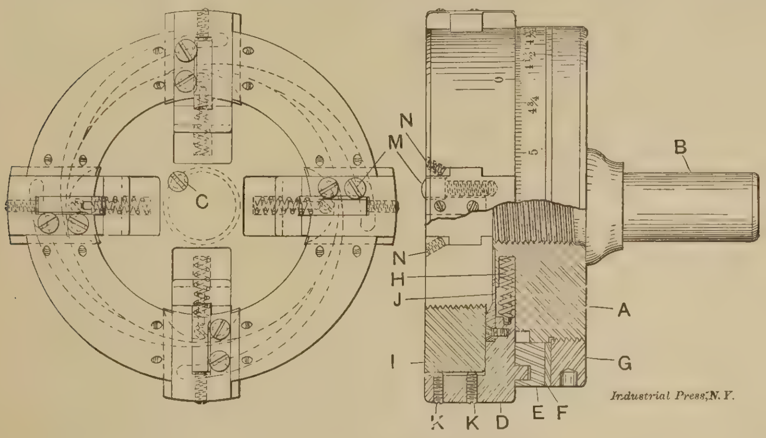


Fig. 1. Combined Adjustable Die and Holder.

Fig. 1 illustrates what is termed an adjustable die and holder combined, and its sphere of usefulness can be appreciated, as it has an adjustment of one and one quarter inches and its threaders are very simple to construct, thereby making them inexpensive to renew. They may easily be made of high-speed steel, which has proved far superior to the regular tool steels when it is properly hardened. The body, *A*, is made from a piece of forged steel, onto which the shank, *B*, is screwed, being locked into place by the screw, *C*, one-half of which is in each piece. The shank is made of low-carbon steel and is hardened. The four jaws, *DD*, are made of machine steel, casehardened, and are a good fit in the body, *A*. Gibs and gib screws, *N*, are utilized to compensate for wear. On the lower part of each jaw is a projection which engages a slot in the cam ring, *E*. The construction of both jaw and cam ring will be more clearly seen by reference to the details shown in Fig. 2. The threaders, *I*, *I*, fit into these jaws and are held by the screws, *MM*, while adjusting screws at the back of the threaders allow for resetting after they have been rehobbed. The springs, *H*, serve to always hold the jaws against the top of the cam groove, thus insuring accuracy. To protect these springs and the inner part of the slot from dirt or chips, when the jaws are set at their largest diameter, the pieces marked *J* are used, being held fast in a slot milled into the jaw, by means of a screw located at the bottom of the threader slot. They are fitted into the body, *A*, so that they will move in and out with the jaw, and are flush with the bottom of the body.

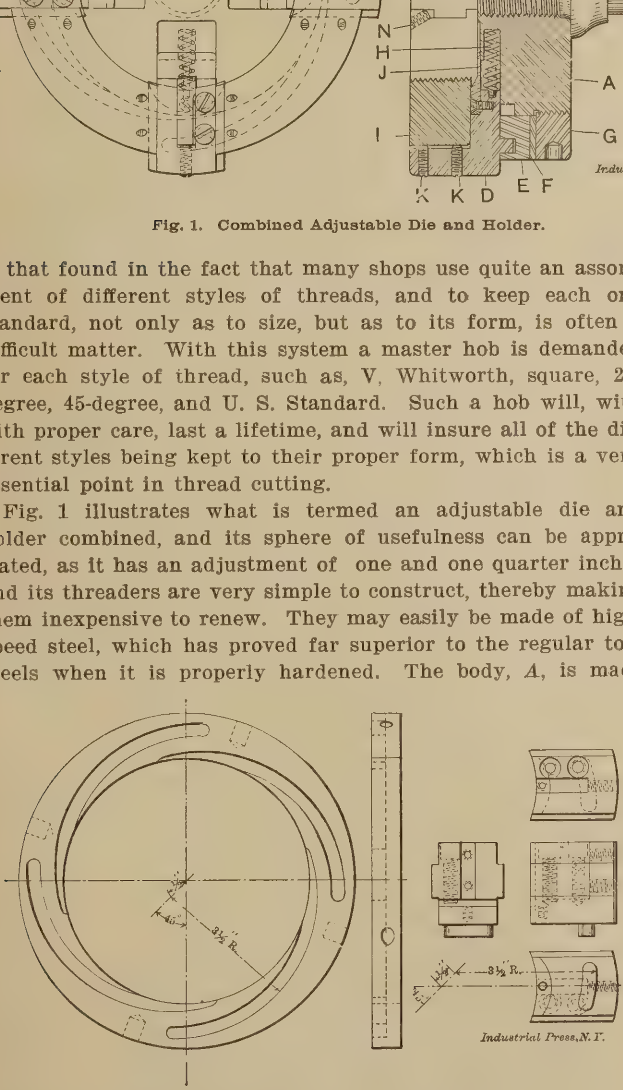


Fig. 2. Detail of Cam Ring and Jaws.

The cam ring *E*, from which the 1¼-inch adjustment is obtained, has four cam grooves, the milling of which presented some little difficulty, but was finally accomplished by use of the special plate and arbor shown in Fig. 3. The shank of this arbor was made to fit the dividing head of the milling machine, and the projecting head was turned to a sliding fit in the plate *B*, and tapped on the end to receive a bolt by which the plate was clamped in position. This plate served as an arbor for milling the cam rings. As will be seen from Fig. 2, these cam grooves are struck from a center which is one-half inch off from the center of the ring, and with a radius of 3½ inches to the further side of the groove. One side of the milling plate, *B*, is turned to fit the cam ring and is concentric with the plate, and on the other side there is a similar projection which is one-half inch eccentric and holds the rings while the grooves are being milled. The plate is first placed on the arbor with its concentric side outward, and to this the cam ring is secured by three screws fitting into the plate. With a graduating tool in the milling machine spindle, and the arbor placed in the dividing head, four equally spaced lines are graduated on the inside of the ring. The ring and plate are then removed from the arbor, the ring taken off and the plate replaced with its eccentric side outward. A line is graduated on the plate so that it will bisect the eccentric boss. The cam ring is then replaced on this side, with one of the four graduations in line with the zero line on the plate, being secured with the three screws as before. The milling machine table is first raised so that the center of the spindle is in line with the center of the dividing head, and is then lowered just 3.344 inches, which amount, with a 5-16 inch cutter, gives a 3½ inch radius on the largest diameter of the cam groove. After the first groove is milled, the ring is released and revolved around on the plate to its next graduation for the second groove, which, with the third and fourth, are all milled in the same manner as the first.

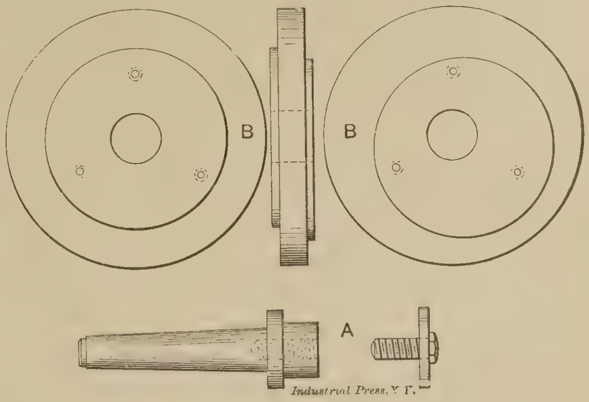
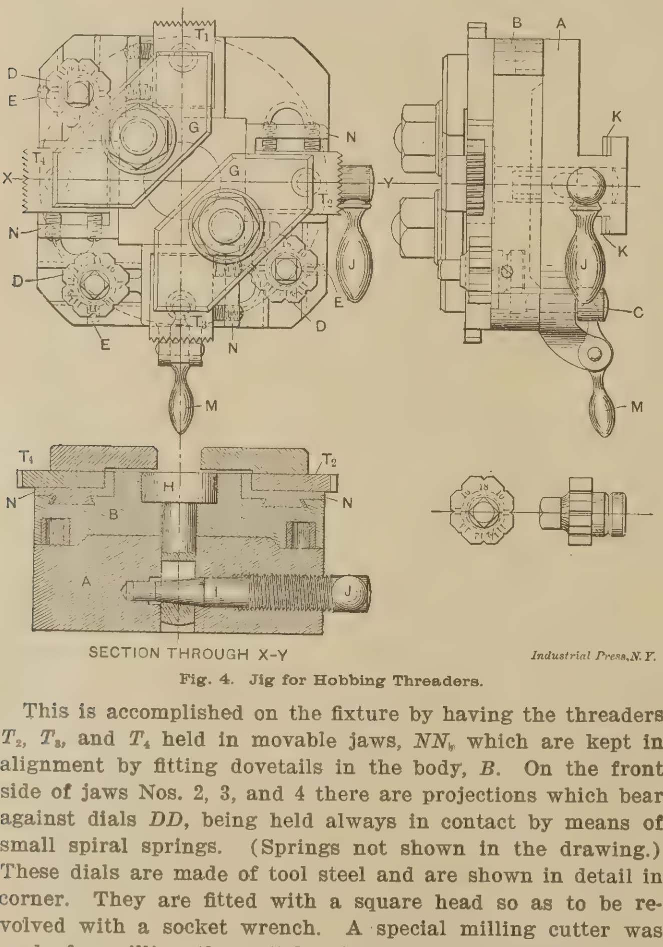


Fig. 3. Arbor and Plate for Milling Cam Ring.

The threaded ring, *G*, Fig. 1, serves to lock the cam ring in position by pressing against the washer, *F*, which is kept from revolving with the ring by a small key set into the body, *A*, and fitting a spline in the washer. It is well when replacing threaders to always adjust them so that the diameter threaded by them will correspond with the graduation which is upon the outer diameter of the cam ring.

The method adopted for making the threaders necessitated the fixture shown in Fig. 4, which was made for use on a lathe with a hob placed between the lathe centers. This hob should be made a trifle larger in diameter than the largest size that is to be cut with the threaders, as a set of threaders that is used on work 4 inches in diameter will not work properly when hobbed with a 3½ inch hob, since the heel of the thread would drag. One hob of a certain pitch will answer for hobbing all threads of the same pitch, provided it is in all cases larger in diameter than the work that the threaders are to act upon.

The body of the fixture is made in two parts, *A* and *B*, the part *A* fitting the tool-post T-slot in the lathe carriage, and being held securely by the two taper keys *KK*, each being placed in position from the opposite sides of the carriage. In the front side of *A* is a hardened and lapped bushing carrying the index pin *C*, which enters four similar bushings equally spaced in the part *B*. By rotating the part *B* and letting the pin *C* engage with each of the bushings successively, the threaders, which are fastened to the top of the part *B*, are brought into position for hobbing. As there are four threaders in the die it is necessary to have them located on the fixture at different distances from the center line; as, for example, in hobbing a threader for a ten-pitch thread, threader No. 2 would be located .025 inch off from the center line, which equals $\frac{\text{Pitch}}{4}$, threader No. 3 would be .050 off, or $\frac{\text{Pitch}}{2}$ and threader No. 4 would be .075, or three times that of No. 2.



Industrial Press, N.Y.

Fig. 4. Jig for Hobbing Threaders.

This is accomplished on the fixture by having the threaders T_2, T_3, and T_4 held in movable jaws, *NN*, which are kept in alignment by fitting dovetails in the body, *B*. On the front side of jaws Nos. 2, 3, and 4 there are projections which bear against dials *DD*, being held always in contact by means of small spiral springs. (Springs not shown in the drawing.) These dials are made of tool steel and are shown in detail in corner. They are fitted with a square head so as to be revolved with a socket wrench. A special milling cutter was made for milling these dials. It had a 90-degree projection upon it, and the slot which it formed in the dial was employed for locating the jaws by means of a similar projection on them.

	Threads per inch.							
	10	11	11½	12	13	14	16	18
Dial No. 2.	.0250	.02273	.02174	.02083	.01923	.01786	.01563	.01389
Dial No. 3.	.0500	.04546	.04348	.04166	.03846	.03571	.03125	.02778
Dial No. 4.	.0750	.06818	.06522	.06249	.05769	.05357	.04688	.04166

NOTE.—Subtract figures of table to obtain difference of dial steps.

Table showing Difference of Settings for Milling Dials.

As will be seen, the dial is divided into eight parts, each being marked with the pitch of the threader which it is to locate. The milling of the dials was accomplished by raising the table of the milling machine the proper amount for each division, the table placed below the detail showing the difference that must be made on each dial, with the corresponding number of threads per inch. The figures are stamped upon the dials before they are milled, so as to avoid any mistake. The dials are held in position in the fixture by means of a small screw, *E*, with a 90-degree point, which fits a slot in the shank of the dial. When the threaders have been located in position they are held securely by the two clamps *GG*.

The cross sectional view of the fixture shows the device that is employed for locking the parts *A* and *B* together. In the central stud, *H*, is an elongated hole through which passes the tapered pin *I*, and when this pin is turned by the handle *J*, it bears against the bottom of the hole in the stud and clamps it firmly. To operate this fixture we first unscrew the handle *J*, and thereby withdraw the taper end of the pin partly out of the hole in the stud, so that it loosens up the part *B*. The index pin *C* is then withdrawn by pulling up on the handle *M*, and the head is revolved a quarter of a turn. A spring attached to this handle causes it to spring into the bushing as soon as it is brought over it.

Another method for accomplishing the threading of the chasers without the aid of so elaborate a fixture as that just described consists in placing the hob on the lathe centers as before, and having a faceplate arranged with as many slots as there are threaders in the die head, care being taken that the slots are equally spaced. A simple fixture is placed on the lathe carriage to hold the threaders in position, and the threaders are numbered as they are cut, the slots on the faceplate having corresponding numbers. After threader No. 1 has been hobbed, the hob is released from the centers and revolved so that its driver will engage slot No. 2 on the faceplate. No. 2 threader is then placed in the same position as was occupied by No. 1 and is hobbed in the same manner. Nos. 3 and 4 are likewise hobbed, using the driving slots corresponding in number. In both of these methods it is understood that the lathe is geared to cut the same number of threads as there are upon the hob.

* * *

A drawback to the general use of nickel steel is the high price of nickel, which is now about 35 cents a pound. This in effect adds $10 to $12 a ton for each per cent. of nickel used, but as the nickel can all be recovered from the scrap, part of the extra cost may be regarded as an investment to be eventually recovered. As interest the user gets wonderful durability under severe stresses, which is especially apparent in locomotive and car axles. The average of forty tests on nickel-steel axles made for the Pittsburg, Bessemer & Lake Erie R. R., which, by the way, has four thousand nickel-steel car axles in use, showed that 67 blows of a drop weighing 1,640 pounds, and falling a distance of 44 feet, were required to break a nickel-steel 5 x 9 inch car axle having a diameter of 5⅜ inches in the middle. These axles contain carbon, 0.26 per cent.; manganese, 0.75 per cent.; and nickel, 3.25 per cent. The deflection after the first blow was 5.2 inches. The Pennsylvania R. R. standard requirements for 5 x 9 inch axles are 5 blows of 1 640-pound drop from a height of 43 feet and a maximum deflection in the center of 5.5 inches.

* * *

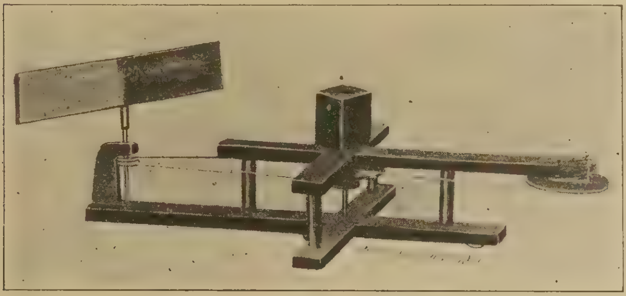
An interesting statement bearing on the future of great cities was embodied in an address recently made by Prof. H. B. Smith of the Worcester Polytechnic Institute, speaking of electrical transmission of power. He said that in San Francisco a few years ago the cost of electric current for power and light was 15 cents for one horse power per hour, while to-day the published price is almost exactly one-seventh of this amount, and it is possible to deliver at the factory on the coast, from the melting snows and glaciers of the Rockies, power for the machinery at a smaller cost than that at which it is possible to produce that power by steam, even though the fuel were to be delivered at the factory boiler without cost to the power producer. It has been estimated that the quantity of carbonic acid annually exhaled by the population of New York city is about 450,000 tons, and that this amount is less than three per cent. of that produced by the fuel combustion of that city; so we may expect that, with the removal of this great source of contamination of the atmosphere, even the air of our greater cities will be practically as pure as that of the country.

LETTERS UPON PRACTICAL SUBJECTS.

SOMETHING FOR THE HOLIDAYS.

Editor MACHINERY:

I am sending herewith photograph of a revolving Christmas tree holder, which you may find appropriate for your December number of the paper. I used the device last Christmas and it worked very satisfactorily. The frame carries a central, vertical rotating spindle, which supports a block for holding the base of the tree. At the right is a clock movement for furnishing the power and at the left a fly governor for regulating the motion of the tree and clock movement. I fitted the device with an old alarm clock movement, taking all the wheels out except the ones attached to the spring axle and to the main axle, which geared together. The wooden pulley below the movement was attached to the main axle of the works, and a cord led from this pulley to a small pulley on the central spindle supporting the tree. A large pulley, also, on this spindle drives the governor shaft by means of a cord, as shown.



Apparatus for Revolving Christmas Trees.

In making a mechanism like this, it would be well to have the governor wing a little lower down so the lower branches of the tree will clear it. The one that I have made will turn a medium-sized Christmas tree for from 20 to 25 minutes before it is necessary to rewind the clock spring. It is possible that some of your readers, who intend to celebrate Christmas by means of a tree for the younger members of the family, would like to make a revolving Christmas tree holder like this one.

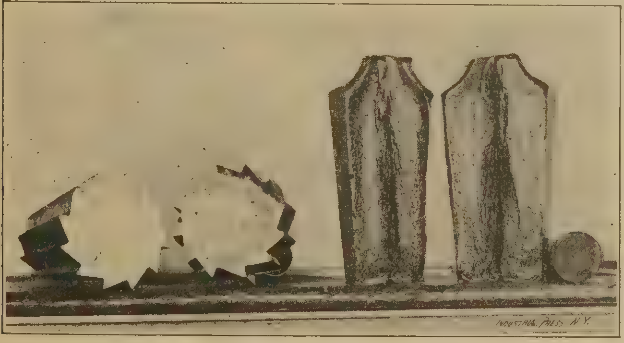
MAX SCHILLING.

St. Paul, Minn.

WHAT CAUSED THEM TO BREAK?

Editor MACHINERY:

The accompanying photograph illustrates two reamers that broke in hardening and it is hoped that they will call forth some opinions as to the cause of their doing so. They were made of the very best of tool steel purchased from one of the leading steel manufacturers especially for this purpose.



Reamers Broken in Hardening.

The dimensions were as follows: Length of taper 7 inches, length of parallel shank 6 inches, largest diameter 4½ inches, smallest diameter 3½ inches.

The reamer at the right was made first and this split lengthwise and in a few hours the shank broke off. The toolsmith was so confident that he could temper another successfully that a second one was made and this broke crosswise at about one inch from the large end, as shown at the left of the cut. A third one was then made with a taper hole throughout its entire length, two inches in diameter at the large end and having the same taper as the blades of the reamer, a shank being made later to fit it. This one came out of the hardening in good condition and is now in use.

It may be said that the smith was a very reliable man, of wide experience in this line of work, with which he is usually successful. The reamers were heated slowly and evenly in a charcoal fire and dipped in warm water—in fact, they received exactly the same treatment as has been given to other reamers by the same man with excellent results. Now I would like to hear from some of the readers of MACHINERY as to what they think was responsible for the breaking; whether the trouble was with the steel, the toolmaker or the smith. I have a theory of my own which may be submitted later.

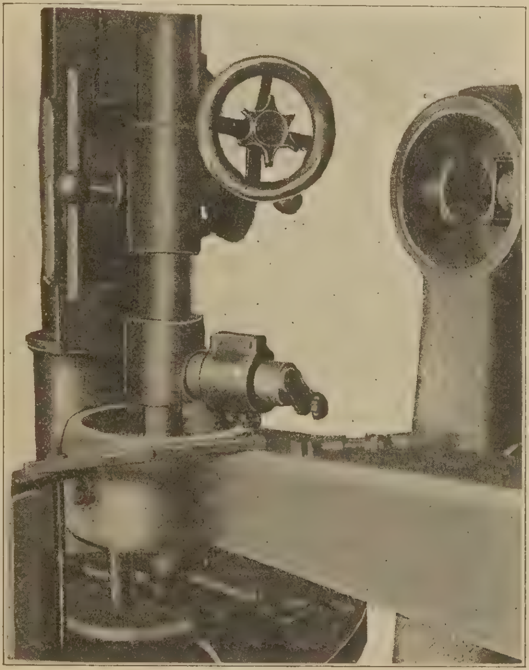
M. H. WESTBROOK.

Port Huron, Mich.

LARGE FACING WITH AN UPRIGHT DRILL.

Editor MACHINERY:

While we are all interested in well equipped shops, and special machines are being put into use for facilitating work, it is doubtful if the time will ever come when it will not be necessary, at times, to use machines for work which was not intended for them. The accompanying photograph shows a job of this nature which was done in a 27-inch Barnes upright drill. A motor field, integral with the column of the machine, is being bored and turned where the hood carrying the other bearing fits on. The hole for the front bearing case is 4¼ inches in diameter, as is the bore of the steel pole pieces, and the surface on which the tool is shown at work in the photograph is 11 inches in diameter. The tool is 5-16 inch square and is held directly in a socket provided for it in the sleeve which slides upon the radial arm. This arm forms one piece with the hub that is clamped on the end of the drill spindle. The boring bar is shrunk in this hub and has a bearing in the drill table.



Facing Motor Columns on an Upright Drill.

The writer believes that some attempts at large diameter work in the drill press are failures because the tang of a taper shank bar is depended upon to drive the cut. In the arrangement shown here this is not used but all driving is done by the outside of the enlarged end of the spindle. The feeding of the tool radially is done by hand as the surface is but ⅞ inch wide and there would be no advantage in having a power feed, although a star feed could easily be provided.

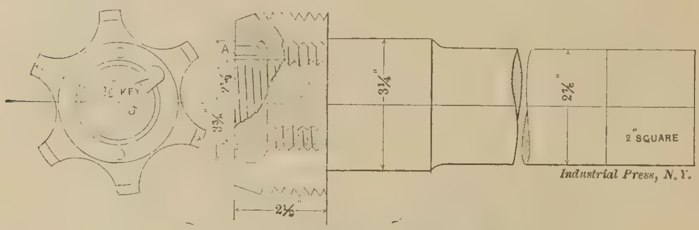
Another peculiarity of this job is that the work is held firmly onto the drill table by pouring babbitt around two projections on the casting and into two slots in the drill table. The close proximity of the drill press to the babbitt bench renders this a good way of holding the pieces. Two light clamps help to secure the work, and that it is held as solidly as if it were one piece with the machine need not be doubted. About fifty motors have been machined in this way and it has not been found difficult to do a true job in a very fair time. CORNEIL RIDDERHOF.

Grand Rapids, Mich.

DETAIL OF LARGE SHELL TAP.

Editor MACHINERY:

The writer noted with interest the account in the October number of MACHINERY of H. H. E.'s accident in hardening a large tap. The accompanying sketch shows the form of tap that is used at the Cramp Shipbuilding Co. for taps of the size described by H. H. E.; no tap over 4 inches in diameter ever being made from the solid. Taps of this design have been made in sizes up to 6¼ inches in diameter, four threads, and have given very good results. The shank of these taps is made of mild steel and can be of any length that is convenient. The tap proper, or shell tap, is held to the shank by a spanner nut, *A*, which fits the end of the shank and a key is used to keep the shell from turning on the shank. The sketch shows the dimensions which would apply to a 5-inch tap. Other sizes would be in proportion and several sizes of tap shells may be made to be used on the same shank.



Industrial Press, N. Y.

Large Shell Tap.

While there is much that is to be said about taps a great deal depends upon the quality of the steel that is used for making them. Although they will sometimes crack and break with the most careful treatment, if good stock is used good results will usually be obtained. F. HARRISON.

Philadelphia, Pa.

SPIRAL GEAR-CUTTING MACHINES.

Editor MACHINERY:

I am able to furnish some of the information desired concerning the spiral gear-cutting machine illustrated in your issue of November.

The reason that the machine is not made in this country is that I hold a patent upon it. I am not making it myself because I am not a machine-tool builder, and cannot induce any manufacturer to take it up for me. The patent will probably run out its term unused.

It is only fair to intending purchasers to record my claim that the Biernatzki & Co. machine which you illustrate is a direct infringement upon my patent, and that anyone who purchases one without a permit from me is liable to be called to account by my lawyer. The machine, as made by this firm, is patented in this country by Phauter, and a most cursory examination of his patent of January, 1900, will show that his invention is fully included in mine and covered by my claims.

My patent is disputed by several concerns who imagine that it is cheaper to steal my invention than to purchase it, but it is to be noticed that every one of these concerns has adopted the futile device of secrecy. They have the machines working in locked rooms, out of sight, and imagine them out of reach. When the patent runs out these machines will blossom forth as brand new. Not one of these infringers will discuss the matter of validity, for the simple reason that they have no argument to offer. I am preparing a suit against one of them which will test the matter. Intending infringers and importers of infringing machines will do well to wait the decision of the court in this test case.

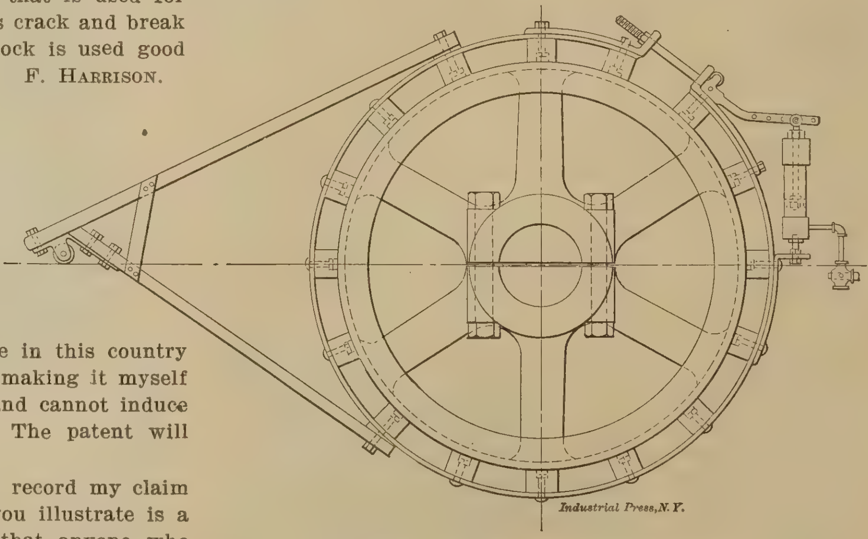
That the invention is practical is proven by the uniform success of the machine when properly made. I do not doubt that it will appear under names of Smith or Jones, or otherwise, as soon as my patent is out of the way, and that it will be the future method of cutting spur and spiral gearing in regular manufacture. It is not very well adapted to the jobbing trade, but for turning out gears in rows by the hundred it is the coming thing. The machine is described in my Treatise on Gear Wheels. GEO. B. GRANT.

A QUICK-ACTING ATTACHMENT FOR THE PRONY BRAKE.

Editor MACHINERY:

The office of the Prony brake in connection with the testing of dynamos, motors, steam and gas engines is to hold a load on a band wheel used in connection with the brake band. The load is maintained constant by the use of a wrench or hand wheel with which the band is tightened or loosened as the case may require. This method is, however, by all means too slow for obtaining good results when variations of the load are often from 0 to 125 per cent. overload and take place so rapidly that hand regulation would be impossible. The accompanying sketch shows a brake which is fitted with a quick-acting attachment that makes it suitable for this kind of testing.

A small cylinder, having a diameter of about three inches, is fastened to one-half of the brake band and to the upper end of the piston rod is connected a short lever which supports a cam on the end toward the band. Power, which may be either steam, hydraulic, or compressed air, is supplied to the cylinder by a ⅜-inch pipe entering on the lower side of the piston. When pressure is admitted to the cylinder the piston is forced upward and consequently imparts an upward motion to the short lever on the end of the piston rod. This causes the cam on the end of the lever to close the band and to hold the load at any desired point, this being regulated by the amount of pressure that is admitted to the cylinder. In order to make this application complete and at all times under control of the engineer, a ⅜-inch plug cock of ordinary style has been placed in the supply pipe line at whatever point is the most convenient for operation. This cock has a 5-16-inch hole drilled through one of its sides and a similar one drilled half way through the plug, thus forming an outlet on the cylinder side of the cock for release of the pressure in the cylinder. Thus it will be seen that closing the cock to pressure opens it to release and the pressure in the cylinder immediately falls. In using this arrangement from 1 to 500 horse power can be instantly applied by simply moving the lever on top of the cock, and release is as easily obtained.


Industrial Press, N. Y.

Prony Brake with Quick-acting Attachment.

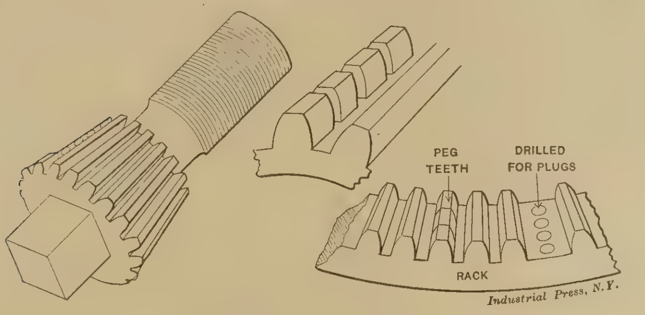
Oswego, N. Y. JAMES H. TAYLOR.

THE TOOLMAKER IN THE SMALL SHOP.

Editor MACHINERY:

Among the many odd jobs that come to the toolmaker in the small shop is the taking out of broken taps and setscrews from various pieces of work. Of course it is careless on the part of the workman, or so the toolmaker thinks, forgetting that he broke a small tap himself in the very last job he made, but it has to be fixed just the same, and so he goes at it.

If it is a tap or a hardened setscrew the first operation is to draw the temper so it can be drilled easily, and the best manner of doing this depends on the kind of a piece it was broken off in. When it's a small tap in a big piece of work that you don't want to heat all over, the temper can sometimes be drawn with a blow-pipe, playing the flame directly on the broken piece. It is better, however, to get it as soft as possible so as not to make the drilling out hard or to increase the tendency of the drill to run into the softer metal, in this case, the work.



Repairing a Geared Chuck.

In the case of a setscrew you can sometimes drill out so close as to leave nothing but the thread in the holes, and this can then be easily removed. This cannot often be done, however, as it is difficult to keep the drill running true enough to avoid cutting away the thread on one side or the other. It is decidedly safer to use a drill that will leave about a sixteenth of an inch on a side. Then, unless the setscrew is a particularly tight fit, a square punch can be driven into the hole firmly enough to unscrew it with. If, as is usually the case, the setscrew was broken from setting it up too tight on a shaft, this pressure will be relieved when the drill reaches the end of the screw, even if it does not drill through into the shaft. The square punch usually takes them out, but at times it is necessary to split the shell which remains, with small cape chisels. A careful man can usually get them out without much damage to the tapped hole. Where damage cannot be avoided it is often necessary to tap the hole out with a larger tap. I believe this practice is largely responsible for some of the odd sizes we find in some shops.

Practically the same treatment is needed in the case of a broken tap, but more care is generally required. A small hole is necessary owing to the grooves cut into the sides, and this makes it harder to remove the broken piece, as there is such a small chance of getting a good grip with a punch driven into the hole. It is a mean job at best, and a man who has had the pleasure of drilling a tap out of a piece of work will be almost unduly cautious for some time to come.

Another job that isn't altogether pleasant, though preferable to the drilling out of taps, is that of playing at dental surgery with the teeth of geared chucks or other gear teeth. The universal chuck is perhaps more largely used in brass work than any other line, and the brass chips find their way into the internal regions of the aforesaid chuck with great rapidity. Then they wedge into the teeth and in an unguarded moment the operator gives a little extra pull, snap! go a few teeth of either the pinion or rack (usually the former) and the chuck is on the repair list again.

The toolmaker takes it apart, locates the damaged teeth, and goes to work by drilling a row of holes fairly close together, as shown by the illustrations. The width of the teeth at the base determines the diameter of the holes, and he files or chips the broken tooth to a fairly level base before drilling. Then he takes steel wire rods—either Bessemer or drill rods—and drives into the holes, leaving a little extra length to file off for a finish. The next step is to file up the sides as nearly like the teeth in the pinion or rack as possible, although at best it is enough to make a regular gear man shudder. But they do the work and the false teeth almost never break, even when made from Bessemer rods.

Putting the chuck together again so it will run true isn't such an easy matter unless you've been there before. The quickest and surest way is to first put it together without the rack. Put it on the lathe where it belongs and, using it as an independent chuck, true up a mandrel or other round piece in it. Leaving this tight in the jaws, take off the back, put the rack in place and put together again. It will generally be found to run true after this, although there may be slack enough in one pinion to throw that out a little. If so, this particular pinion probably needs to be turned one tooth in one direction or the other to make it right. One thing is certain, if it ran true before you commenced your dental operations, it can be made to again. In many ways the universal chuck for anything larger than a drill chuck, is a delusion and a snare. As any mechanic who has handled them knows, it is a miracle when they run true for any length of time and they are weak as compared with an independent chuck.

It is also true that much of the trouble with chucks of this class comes from improper handling. If you attempt to tighten a piece of work from one screw, as you might do in a three-jawed independent chuck, you are very apt to have trouble. Either the teeth will break out or the work will not be firmly held.

The man who has had experience of this kind, tightens up on one screw until he grips the piece, then he turns the lathe and tightens each screw separately, perhaps two or three times. This uses the rack simply to bring the jaws to the work and tightens by each screw as it should.

Repairs can also be avoided by cleaning universal chucks occasionally—not to wipe out the oil, as they are generally kept dry on brass work, so the chips will not stick, but to clean out the little chips and brass dust. These pack into the teeth and cause trouble. For cleaning, just clamp a piece into the jaws, take off the back, get out the dirt and put back the rack and other parts removed. This keeps the jaws just where they were and saves any readjusting.

FRED. H. COLVIN.

SOME MORE MICROMETER MEASURING INSTRUMENTS.

Editor MACHINERY:

That micrometer lathe stop which was shown by Mr. Cantelo in the July number of MACHINERY is certainly a good one, but the writer takes the liberty of suggesting an improvement in its construction. Without doubt this is one of the most accurate and universal tools in use, but the description referred to showed an instrument that is limited in its use to work where only a stationary height is required. It is, however, often necessary to use the stop at different heights, to accommodate different lathes; then again, we wish to use it on the right-hand side as well as the left. The form of holder shown in Fig. 1 can be used either right or left, and for various heights and, by simply taking out the screw, *A*, the micrometer may be removed and used in any other form of holder desired.

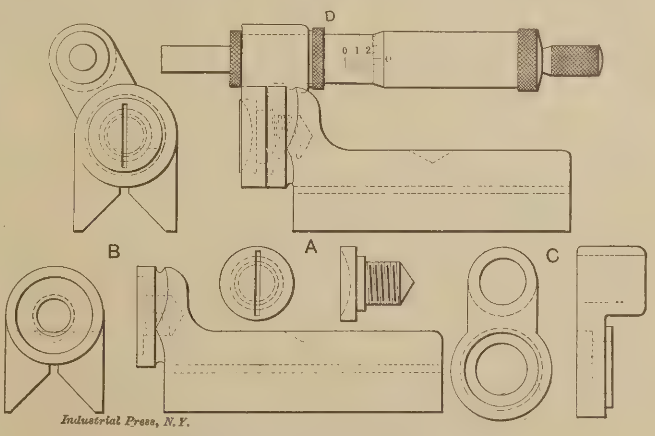


Fig. 1. Micrometer Lathe Stop.

Both assembled view and details of the holder are shown in the figure so that it can be easily constructed by any one desiring to do so. The micrometer and barrel may be procured from any of the manufacturers of measuring instruments. The swivel *C* is bored out so that the axis of the micrometer screw will be parallel to the body of the holder

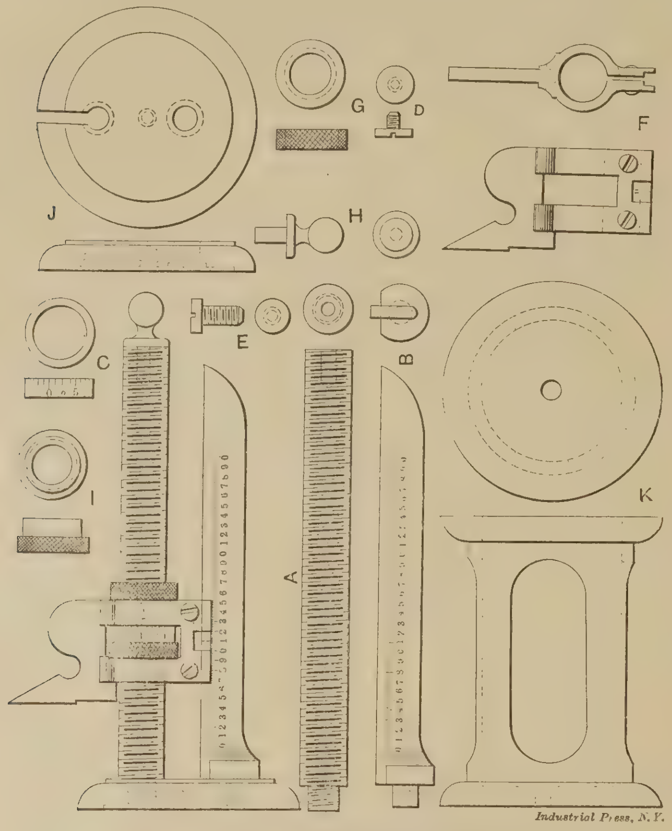


Fig. 2. Micrometer Surface and Height Gage.

when it is in place. The swivel is made of tool steel and is fastened to the holder by the screw *A*. It is hardened and lapped to a true bearing surface on the sides and bottom and so adjusted that it will turn to either side and remain in desired position without moving the screw. The holder *B* is milled through its entire length with a 45-degree cutter so that it will fit along the ways of the lathe, and the bottom is lapped to a true surface. For a neat appearance it should be color hardened. On top of the holder the point of a drill is entered a short ways to form a recess for the *C* clamp. A knurled ring *D* is driven onto the micrometer sleeve so that it can be turned around to bring the graduations uppermost when the position of the barrel is changed.

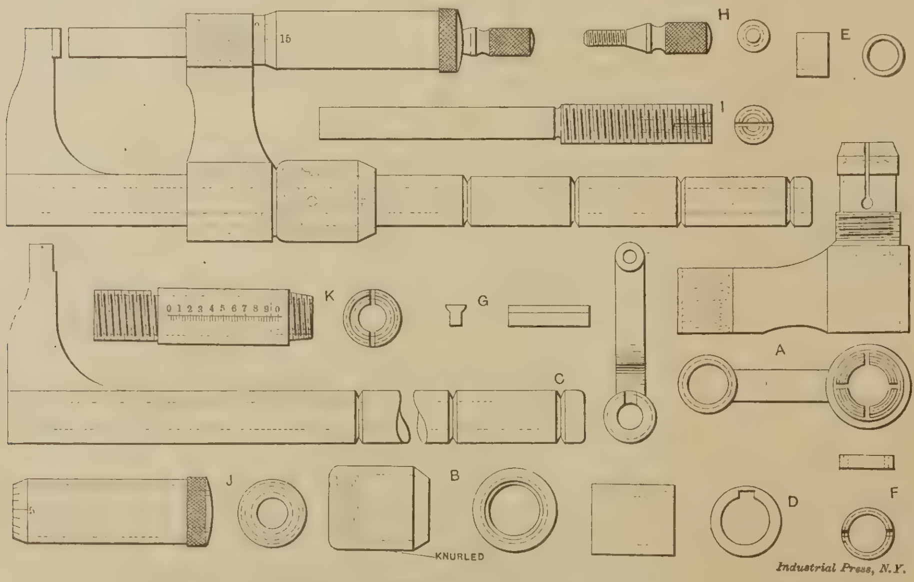


Fig. 3. Five-inch Bar Micrometer.

Fig. 2 shows a form of surface gage that has proved very handy and can be used also as a height gage for measuring distances from shoulders to the base. If accurately made it is equal, and often preferable, to the vernier or slide caliper now so generally used with an attachment to the sliding jaw. One of its advantages over the vernier is the readiness with which the graduations are discerned, and it is as easy to manipulate as the ordinary micrometer. The part *B*, which forms the main body of the instrument, is made of tool steel and one end is fitted into the base where it is held in position by the screw *D*. The other end is milled to a thickness of ⅛ inch and has graduations of .025 inch for a distance of three inches. The screw *A* is the most essential part of the tool and its construction requires great accuracy. Its diameter is ½ inch and it is cut with 20 threads per inch. On the upper end of the screw is driven the ball *H* for the sake of giving a neat appearance. The top of the thread is turned off .01 inch to allow the scriber *F* to slide freely on the screw. The barrel *I* is used for raising and lowering the slide but instead of having the graduations placed directly upon it they are made upon the sleeve *C*, which fits over a shoulder on the barrel. This allows for more easy means of adjustment than would be possible were the graduations placed on the barrel itself. The sleeve is graduated with fifty divisions each equaling a movement of the scriber of .001 inch. This sleeve may be turned by means of a small spanner wrench so as to bring the zero line into correct position to compensate for wear. A knurled locking nut is also provided for holding the scriber in any fixed position. The scriber itself is hardened and lapped to a finished surface, the tail end being slotted and provided with two screws to compensate for wear. On the scriber is placed the zero mark which shows at a glance the measurement that is being taken. The block *K* is three inches in height and is so constructed that by placing the gage on its top the range of the gage is increased to six inches. The screw *E* is used for fastening the gage to the top of the block. The center of the block is drilled out and slots cut through the sides in order to make it light and neat in appearance.

Fig. 3 shows a very simple and light five-inch micrometer that can be quickly set to exact position from one to five inches. The round beam is graduated by a series of angular grooves, 1 inch apart, which are of such a form and depth that the clamping fingers at the end of part *A* spring in, allowing one inch adjustment of the beam to be quickly and positively made. The sleeve *K* is of tool steel, being counterbored from the forward end for all but one-half inch of its length. For this half inch it is threaded on the inside and acts as a micrometer nut. The outside of the same end is threaded to receive the adjusting nut *F*, and two slots are cut in the sleeve, at 90 degrees with the graduations, so that these, by a movement of the nut *F*, provide a means for compensating for wear. The bushing *E* is hardened and lapped, and fitted tightly in the forward counterbore of this sleeve where it acts as a guide for the front end of the micrometer screw. The barrel *J* is the same as that of a regular micrometer and is graduated in .025 inch divisions.

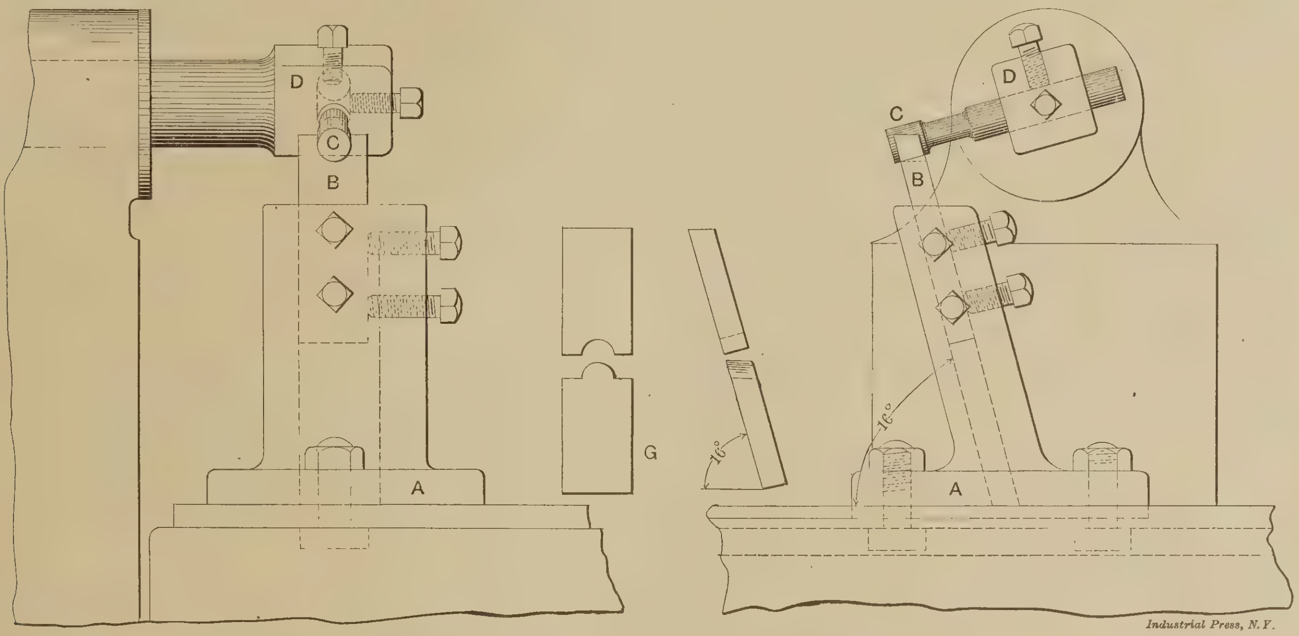
The most essential part of the tool is the threaded screw *I*, over the end of which fits the barrel *J*. The end is tapped out to receive the speeder *H*. which serves to hold the barrel in position. The thread is 5-16 inch in diameter and threaded 40 pitch, while the unthreaded part is hardened, ground and lapped. To adjust the instrument, loosen the speeder *H* and turn the barrel until the proper adjustment is obtained; lock the barrel by again tightening the speeder. The beam *C* has a ¼-inch hole drilled throughout its entire length in order to make it light. Small 90-degree grooves are cut into it at intervals of 1 inch, and a ⅛-inch slot is milled through one side to within 1¼ inch of the forward end. The back end of part *A* forms a spring-tempered split chuck, which grips the beam and holds it in position, while the exterior is threaded to receive the knurled cap *B* by which the chuck is tightened firmly to the beam. From the front end, toward the split chuck, the body is counterbored ⅝ inch and the bushing *D* driven in tight. This bushing has a key *G* fitted into it which slides in the slot of the beam and prevents the arm from turning. The projecting arm is bored and tapped to receive the sleeve, *K*. This gage has proved one of the writer's handiest tools but it must be carefully and accurately made to be of value.

New Haven, Conn. A. L. Monrad.

MAKING A CONCAVE FORMING TOOL.

Editor Machinery:

The accompanying drawing illustrates a method of making a concave forming tool such as is used for backing off convex milling cutters. This tool is required to have the same shape for its entire depth so that it may be ground and reground without changing its original form.



Industrial Press, N.Y.

Shaping a Concave Forming Tool in the Milling Machine.

In the sketch, *B* represents the tool which is held in the holder *A* at an angle of 16 degrees with the table of the machine, this inclination giving to the tool the proper cutting clearance. The first thing to be done, after placing the tool in the holder, is to mill off the top of the tool so that it will be parallel with the table of the machine. A semicircle of the desired radius is then drawn on the back of the tool and with any cutter that is at hand, it is milled nearly to the mark, care being taken not to go below it. For finishing the cutter a plug, *C*, is made, the end being hardened and ground in a surface grinder. This plug is held in a special holder, *D*, which fits the spindle of the milling machine, and when it is set so that its axis is perpendicular to the tool the spindle of the machine is firmly locked. Some machines are now being built with provision for locking the spindle, but if not so made the same result may be accomplished by driving wedges under the cone pulley. Now by moving the platen of the machine backward and forward by hand the plug can be made to cut a perfect semicircle in the tool.

It is good practice to plane a little below half of the diameter of the plug, thus allowing some stock to be ground off after the tool is hardened. In hardening, these tools usually come out very satisfactorily, but if any distortion takes place it will be from the sides and may be readily remedied by a little stoning.

By using the concave tool for a planing tool, as shown in the sketch at *G*, a convex tool may be formed, but in doing so care should be taken that both tools stand at an angle of 16 degrees with the bed of the machine. This shape of tool would be used for backing off a concave cutter.

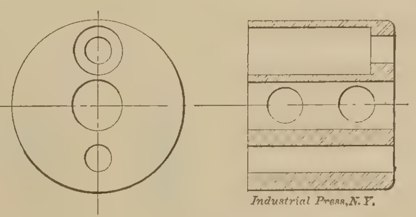
Providence, R. I. J. J. Lynskey.

A TIME-SAVING DRILL JIG.

Editor Machinery:

The drill jig which is here illustrated and described had considerable influence in establishing the cost of production, and maintaining the uniformity of the piece shown in Fig. 1, and although there is nothing remarkable in its construction, it embodies one or two points of interest since it is rigid and simple and is designed to withstand the severe handling that a tool of this kind usually receives from unskilled workmen, and at the same time it is capable of producing very satisfactory results. The pieces are first turned in the lathe to the proper size and length and the hole through the center is drilled at the same time. The object of the jig is to drill the side holes and the two end holes, which are diametrically opposite, one of them being stopped off at ⅛ inch from the bottom and continued through with a smaller size of drill.

This jig, which is shown in Fig. 2, consists of an L-shaped casting, *A*, which is supported on its bottom or side by the steel legs, *BB*, the faces of which are hardened and lapped true. A hole is drilled straight through the jig from top to bottom and into the top of this hole is forced the bushing, *C*, of tool steel, having a No. 19 and a ¼-inch hole, also a guide for one end of the work projecting at the center on the lower side. This is forced into the jig from the inside until the shoulder bears firmly against the upper arm of the jig. This combined bushing and guide was made in a single piece instead of inserting drill bushings and a guide piece separately, because the variation allowed for the holes was greater than any that was likely to be incurred in the hardening of the piece.



Industrial Press, N.Y.

Fig. 1. One of the Pieces to be Drilled.

Fitted tightly in the hole in the base of the jig is the sleeve, *D*, which carries a traversing piece, *E*, with a guide point on one end directly opposite and like the one in the upper bushing. These guides fit the hole in the work which is advanced or withdrawn by means of the screw, *F*, which is fastened to the piece *E* by the pin, *G*, introduced in such a location that the side rests in a round groove on the upper end of the screw, attaching it thereto and at the same time permitting it to rotate freely. The end of a small pin, *H*, enters a spline in the side of *E* and checks any tendency that it may have to turn when the screw is being turned. A knurled head is pinned and riveted on the end of *F*, as shown in the cut.

A strip of machine steel, *J*, of sufficient length to extend from top to bottom of the jig, is seated in a square milled channel and fastened by screws and dowel pins. The side holes were carefully located in this strip and two hardened and ground bushings for No. 4 drills were pressed in.

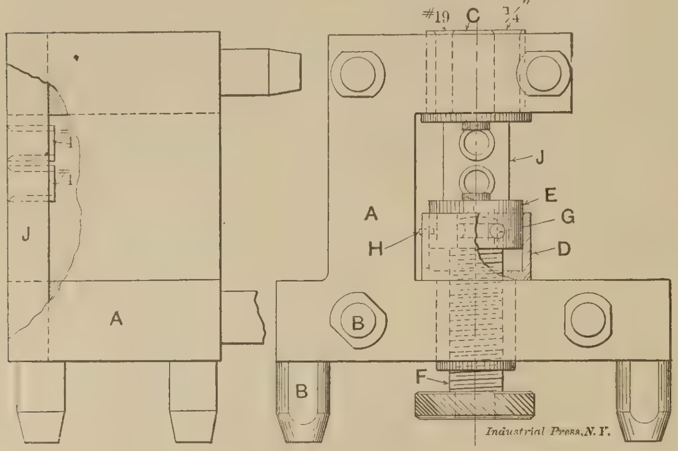


Fig. 2. Jig for Drilling Pieces shown in Fig. 1.

When in use the work is slipped on the upper guide point and, when the piece *E* is advanced by the hand screw, it is held firmly in place, being properly located in relation to the bushings by the center hole. The piece is then drilled as in ordinary jig drilling, the finished piece being removed by simply loosening up the hand screw. The piece, *E*, with the exception of the guide on its end, is left soft for the point of the drills to enter the necessary depth for clearance.

Worcester, Mass. C. H. Rowe.

THE TOOLS FOR MAKING BOX CORNER FASTENERS.

Editor Machinery:

Many of the readers of Machinery are doubtless familiar with the crinkled metallic fasteners that are used for strengthening the sides of boxes after they have been put together, as is shown in Fig. 1, which is a corner of a box into which one of these fasteners has been driven. These articles are used in large quantities and are sold very cheaply as they are produced in one operation by the means of dies to which the stock is fed automatically. As the manner in which they are made is suggestive for other work of a similar nature, a description of the tools used may be of interest.

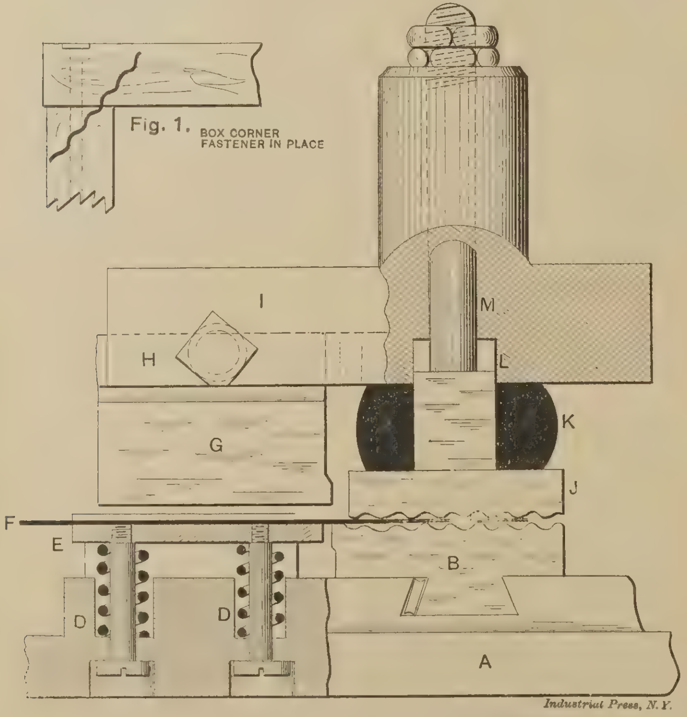


Fig. 2. Punch and Die for Box Corner Fasteners.

In Fig. 2 is shown a front view of the punch and die as they appear when in the press. As will be seen the tools are constructed so as to allow of feeding the metal in strips and producing the finished article in a single operation. In the die, *A* is the die block, which contains the spring pad *E* along which the metal is fed, and the combined cutting off and forming die, *B*. Fig. 3 shows a plan of the punch looked at from below. The punch consists of the usual cast-iron holder, *I*, the cutting off punch, *G*, and the forming punch, *J*. It will be noticed that the cutting off punch is let into a dovetailed channel in the face of the punch holder and fastened in position by the large setscrew, *H*. This allows for the adjustment of the cutting off punch when its face and that of the die *B* are ground. The forming punch *J* is furnished with a stem, *M*, which fits a reamed hole running through the stem of the holder, while the punch proper locates in the channel *L* cut in the face of the holder. *K* is a piece of hard spring rubber placed between the face of the holder and the back of the punch. The punches, *G* and *J*, were hardened and drawn to a dark straw temper while the die *B* was drawn to a light straw.

When the tools are in use they occupy the position shown in Fig. 2. The strip of metal is fed along the face of the spring guide way, *E*, the feed being automatically adjusted to project a certain length of strip across the face of the die at each stroke. As the punch descends this portion of the strip that is to be formed is cut off by the punch *G* and the section is held on the face of the die by the punch, *J*, which remains stationary while the cutting off punch and the spring guide may continue to descend, the rubber compressing meanwhile, until the punch *J* bottoms in the punch holder, when it presses the strip into the desired form. As the press is inclined the finished piece slides off from the face of the die as soon as the punch has risen sufficiently to release it. By the use of these dies the articles are produced very rapidly and cheaply. Metal Worker.

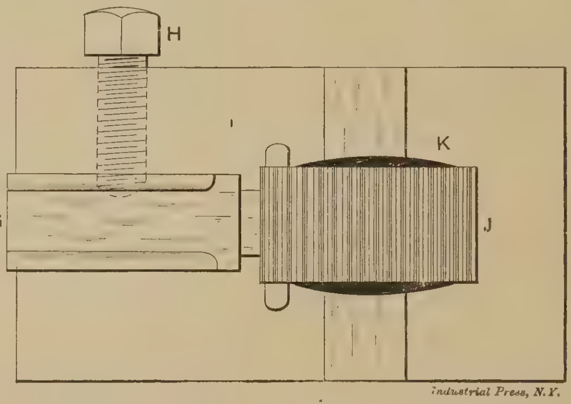


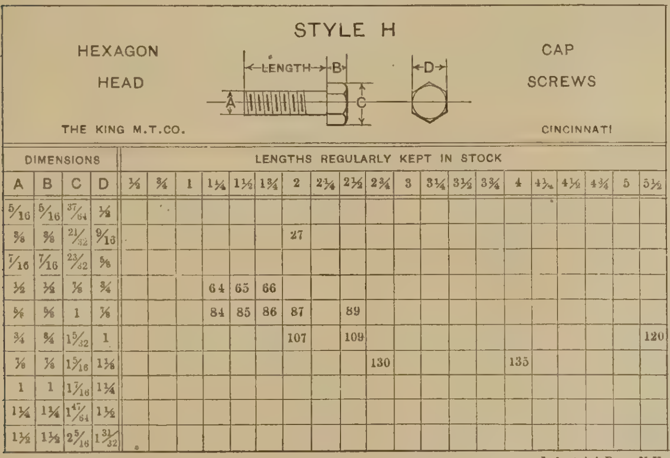
Fig. 3. Plan of Cutting and Forming Punch (from below.)

* * *

Some beautifully smooth examples of planer work are daily produced at the works of the G. A. Gray Co., Cincinnati, O., especially such parts as have to be scraped and fitted. An interesting kink in this connection may be mentioned. As everyone knows who has had experience in scraping planer work, there may be a great difference between the scraping required on two pieces that appear to casual inspection of the eye to be equally smooth. But the moment a scraper cut is taken over the surfaces, the difference is detected. One may show that little work is required; the other will at once disclose that the surface is a succession of "hills and dales," the working down of which requires a lot of time and labor. When the scraping department is on piecework the men naturally object strenuously to the latter class of planer work. To prevent this trouble in the Gray works, each planer hand is required to place a "telltale" on each planer job that is to be scraped. He does this by taking a few strokes with a broad scraper across the work; if it shows up satisfactorily he removes the job from the platen, but if not another finishing cut must be taken. The telltale is in effect an inspection mark of satisfactory planing.

DESIGNATION OF STANDARD MACHINE PARTS.

The accompanying cuts, Figs. 1 and 2, show sample pages from a book of blueprints used by the King Machine Tool Co., of Cincinnati, Ohio, for designating standard machine parts, such as studs, screws, etc., and which is used in their shop and drawing room practice, and for ordering same from the firms making or dealing in such supplies. The method of designating different screw sizes is of interest and will perhaps be new to many of our readers, although it has been used for some time by a number of concerns, having originated, we are informed, several years ago with the Garvin Machine Co., of New York.


STYLE H

HEXAGON HEAD

CAP SCREWS

THE KING M.T.CO.

CINCINNATI

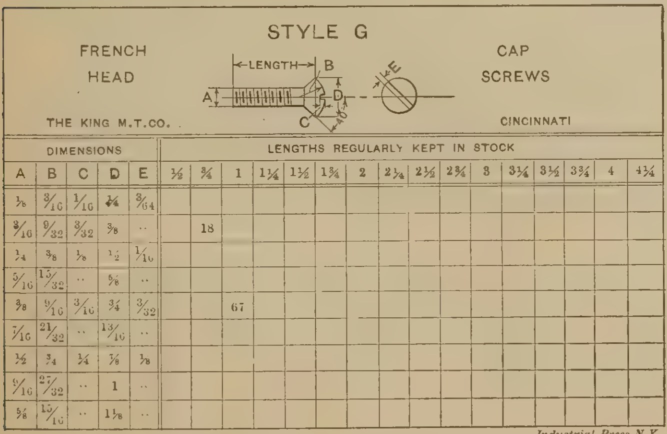
LENGTH
A
B
C
D

DIMENSIONS				LENGTHS REGULARLY KEPT IN STOCK																			
A	B	C	D	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5½
5/16	5/16	37/64	½																				
⅜	⅜	21/32	9/16							27													
7/16	7/16	23/32	⅝																				
½	½	⅞	¾				64	65	66														
⅝	⅝	1	⅞				84	85	86	87		89											
¾	¾	1 5/32	1							107		109											120
⅞	⅞	1 5/16	1⅛										130					135					
1	1	1 7/16	1¼																				
1¼	1¼	1 47/64	1½																				
1½	1½	2 5/16	1 31/32																				

Industrial Press, N. Y.

Fig. 1. Specimen Page for Hexagon Head Cap Screws.

A page of the book, which is simply bound with split staples and marginally indexed, gives the drawing of one style of screw with the principal dimensions designated by *A*, *B*, *C*, *D*, etc.; the name, as "hexagon head cap" in Fig. 1; the style, being "*H*" in this case; and a table of sizes regularly kept in stock. It will be noticed that in the body of the table in this particular case, there are 200 squares, only a few of which have numbers marked therein. These are the sizes regularly used. In this instance the first size regularly used is designated by the number 27. It is a hexagon cap screw ⅜ inch diameter and 2 inches long under the head. The head is ⅜ inch high, 21-32 inch longest diameter, 9-16 inch across flats. All this information is condensed into the symbol "H27." The number is gotten by counting the number of squares, beginning at the upper left-hand corner and going to the right on each horizontal row, successively downward. Thus it will be found that a ½-inch screw, 1¼ inch long under the head, is designated by the 64th square and its symbol, therefore, is H64. Again, if a ⅝-inch screw is wanted 2¼ inches under the head instead of 2 inches (which is H27) it would be designated as H28, and so on. Fig. 2 shows a page given to oval or French head cap screws. In this case the first size regularly used is 3-16 inch diameter and ¾ inch long under the edge of the head; its symbol is G18. In this case it will be seen that the width of the screw-driver slot is also given.


STYLE G

FRENCH HEAD

CAP SCREWS

THE KING M.T.CO.

CINCINNATI

LENGTH
A
B
C
D
E
40°

DIMENSIONS					LENGTHS REGULARLY KEPT IN STOCK															
A	B	C	D	E	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼
⅛	3/16	1/16	¼	3/64																
3/16	9/32	3/32	⅜	..		18														
¼	⅜	⅛	½	1/16																
5/16	15/32	..	⅝	..																
⅜	9/16	3/16	¾	3/32			67													
7/16	21/32	..	13/16	..																
½	¾	¼	⅞	⅛																
9/16	27/32	..	1	..																
⅝	15/16	..	1⅛	..																

Industrial Press, N. Y.

Fig. 2. Specimen Page for French Head Cap Screws.

As already stated, this system is used for ordering stock. Each firm supplying the company with such parts is furnished with a copy of the blueprint book and orders are filled by referring to same. The time required for making out orders is shortened, and the chances for mistakes are lessened. Of course the simplicity of the system on drawings and its advantages in the shop and stockroom are obvious.

* * *

ITEMS OF MECHANICAL INTEREST.

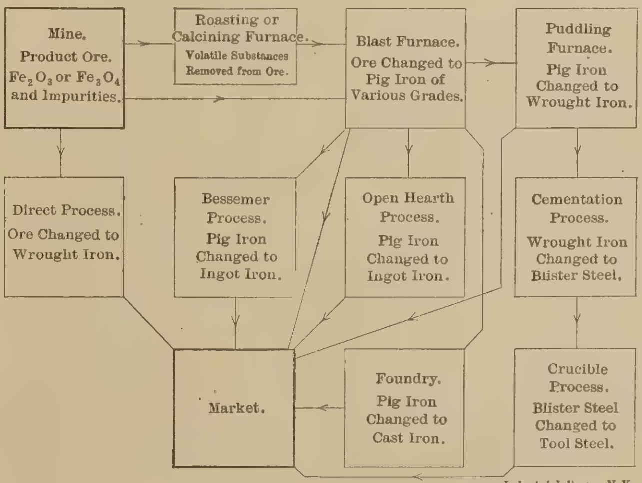
METALLURGY OF IRON—RAILWAY CROSSING PLANERS—GASOLINE HOISTING ENGINE—REPAIRING AUTOMOBILE TIRES.

Alloys that melt at temperatures considerably less than that of boiling water, are found very useful for some purposes, especially for taking casts from delicate objects like fabrics, fruits, animal bodies, insects, etc. But it is asserted that all such alloys must contain cadmium if the objects are to be preserved from injury. A German authority states that such an alloy is Woods metal which consists of tin, two parts; lead, four parts; bismuth, seven to eight parts; and cadmium, one to two parts. This alloy melts at 151 to 162 degrees F. Another alloy, known as Lipowitz's metal—consisting of tin, four parts; lead, eight parts; bismuth, fifteen parts; and cadmium, three parts—softens at 121 degrees F. and becomes perfectly liquid at about 151 degrees.

GRAPHICAL ILLUSTRATION OF THE METALLURGY OF IRON.

The diagram herewith illustrates graphically the metallurgy of iron from the mine to the market and affords an interesting means of tracing out the different processes and showing the kind of steel or iron which each process produces.

Thus we see that the ore may, by the direct process, be changed at once to wrought iron in which form it is placed upon the market. The ore may go to the direct blast furnace or, if volatile substances are contained in the ore, it is first roasted, by which method these substances are removed and the ore made ready for the blast furnace. In the blast furnace the ore is changed to pig iron of various grades which may be placed directly upon the market or it may be then treated by any one of several processes. If treated by the Bessemer process the pig iron is changed to ingot iron, in which form it is placed upon the market. If treated by the open-hearth process it is also changed to ingot iron. If, however, the pig iron is sent to the foundry it is made into cast iron and placed upon the market in the form of castings. In the puddling furnace the pig iron is changed to marketable wrought iron or it may be treated by the cementation process, in which it is changed to blister steel, from which, by the crucible process, we obtain tool steel.


Mine.
Product Ore.
Fe_2O_3 or Fe_3O_4 and Impurities.
Roasting or Calcining Furnace.
Volatile Substances Removed from Ore.
Blast Furnace.
Ore Changed to Pig Iron of Various Grades.
Puddling Furnace.
Pig Iron Changed to Wrought Iron.
Direct Process.
Ore Changed to Wrought Iron.
Bessemer Process.
Pig Iron Changed to Ingot Iron.
Open Hearth Process.
Pig Iron Changed to Ingot Iron.
Cementation Process.
Wrought Iron Changed to Blister Steel.
Market.
Foundry.
Pig Iron Changed to Cast Iron.
Crucible Process.
Blister Steel Changed to Tool Steel.

Industrial Press, N. Y.

Fig. 1. Chart Illustrating the Metallurgy of Iron.

DUPLEX PLANING MACHINE FOR RAILWAY CROSSINGS

The machine shown in the accompanying illustration was constructed at the Ancoats Works, Manchester, England, and was designed for planing and finishing railway crossings to a point, and at various angles, from rails of heaviest sections after they were put together at the required angles. There are two transverse foundation beds arranged to radiate from fixed centers on the front foundation bed. These beds may be set at the various angles by means of screw and ratchet lever and they are then securely bolted to the transverse beds. Each longitudinal bed is provided with a table to support the rail while it is being planed and is also fitted with a saddle or carriage. These saddles have upright angle brackets cast on the upper face and to these are fitted swivel tool boxes arranged with compound slides, self-acting in the vertical and angular cuts. The horizontal adjustment is by hand and spring clapper. Each saddle is driven independently and fitted with adjustable stops for various lengths of stroke. Each bed is provided with a separate set of driving gears with single belt and tight and loose pulleys, and the arrangement of the gears is such as to give a quick-return motion to the saddle of 3 to 1.

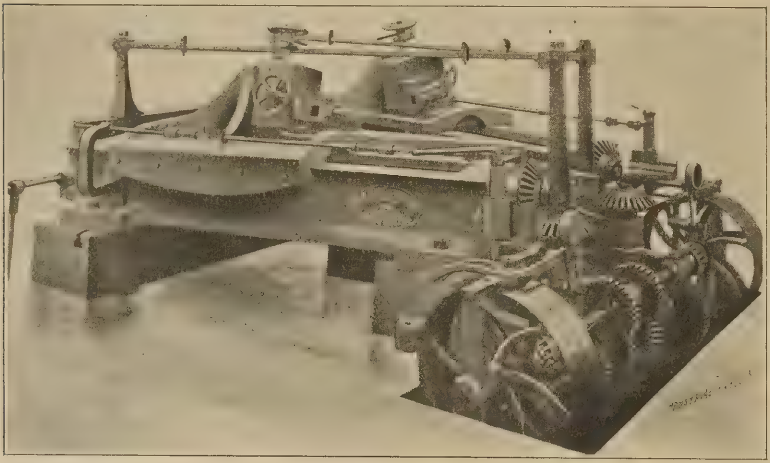


Fig. 2. Duplex Planing Machine for Railway Crossings.

F. C. P.

THE EFFECT OF SUBMERGING COAL.

Considerable attention has been bestowed upon the comparatively recent discovery that coal submerged under sea water does not lose its calorific power so rapidly as when exposed to the air. Indeed, Mr. Macauley, who announced the discovery about one year ago, now states that in some cases there is an actual gain in heat-producing power, but this, as we understand it, does not apply to a unit of weight compared before and after submersion. That is to say, a hundredweight of coal submerged for a certain length of time loses by oxidation very slowly, but it does lose a certain percentage of the softer parts by the process of solution. Thus, the remaining portions may show a gain in calorific power because the proportion of ash and non-combustible matter has been proportionately reduced. This might be an important item in the use of coal for fast steamers, where it is desirable to reduce the actual weight of coal carried to the lowest possible figure, to say nothing of avoiding the loss by oxidation, which is inevitable where coal is stored for some time in the open air, especially in warm weather.

THE USE OF CALCIUM CARBIDE IN SUBMARINE BOATS.

It is generally known that calcium carbide forms acetylene gas rapidly when immersed in water, and, if confined, considerable pressure can be generated in this manner. In the December, 1902, issue mention was made of the suggested use of calcium carbide in a cylinder above a piston for producing heavy pressures, as required for baling cotton, hay, straw, etc. By its use, it was pointed out, such apparatus would be greatly simplified, the pumps and motive power required for a hydraulic press being made unnecessary. This property of calcium carbide has been utilized in Germany in another direction, which also makes the use of pumps unnecessary, and that is for raising and lowering submarine boats. The rapid formation of actylene gas presents a convenient method of increasing or decreasing the displacement of such a vessel as is necessary when it is to be raised or sunk. The boat is supplied with a gas generator connected to the water reservoirs, which act as ballast. The introduction of a carbide cartridge into the generator produces gas which, admitted by a valve to the water reservoirs, displaces the water and lightens the craft so that it rises; releasing the gas so that the water fills the reservoirs, of course, causes it to sink. The apparatus is simple, compact and requires no pumps.

A GASOLINE HOISTING ENGINE.

One of the latest applications of the gasoline engine is its use for hoisting machinery, as illustrated in Fig. 3, which shows a gasoline hoisting engine of recent design. The motive power is supplied by a horizontal gasoline engine of standard type, having directly connected to the crank shaft, by a single gear reduction, a winch shaft which carries a hoisting drum that is made in various sizes to suit the requirements. This drum is controlled, as in the ordinary steam winch, by a friction clutch and brake under the immediate command of the operator. In raising the load the clutch is thrown in; while in lowering, it is disengaged and the speed of the drum is controlled by the friction brake. The speed of the engine may be varied while in operation, and all levers and regulators are operated from one position.

Upon the outer end of the drum shaft is placed a secondary drum or "nigger head," and the outer end of the crank shaft carries a pulley so that the engine may be used for power purposes if desired. When it is so used the hoisting mechanism is disconnected and stands idle. The gasoline tank and the batteries for operating the sparking mechanism are placed in the base of the engine, so that the whole forms a single unit which can be transported as easily as the ordinary steam winch alone, and the need of boilers and feed tanks is obviated. This winch is built by the Columbus Machine Co., Columbus, Ohio.

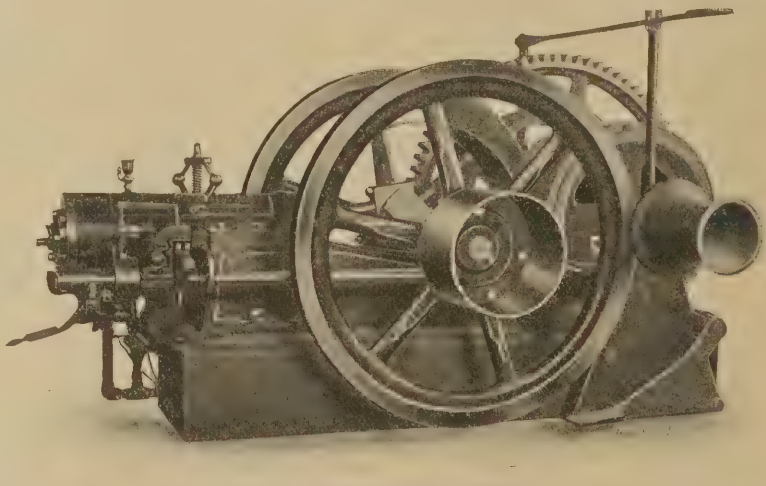


Fig. 3. Gasoline Hoisting Engine.

NEW METHOD OF TIRE REPAIR.

A novel method of repairing automobile inner tube tires has been brought out recently by a European firm of tire makers, which is designed to avoid the troubles incident to the ordinary method of repairing punctures in inner tubes. When patches are applied with cement it appears that they will invariably loosen when run at high speed, and thus cause the deflation of the tire. The only way heretofore to make such a repair reliable has been to vulcanize the patch on the inner tube. The new method makes use of a rubber rivet, *A*, having a hollow stem. This rivet is pushed through the puncture, using a blunt punch for the operation as shown at *B*. After the rivet is in position, a shot such as used in shot-guns of about the size known as B or BB, is pushed through the stem until it reaches the bottom where, of course, it enlarges the stem to a considerably larger diameter than it is in the neck where compressed by the walls of the punctured tube. For large punctures it may be necessary to use a steel ball such as used in bicycle bearings. The result is that the rivet cannot become dislocated when in use without tearing off the stem or greatly enlarging the hole. Of course the under side of the rivet head is treated with rubber cement before being placed in position.

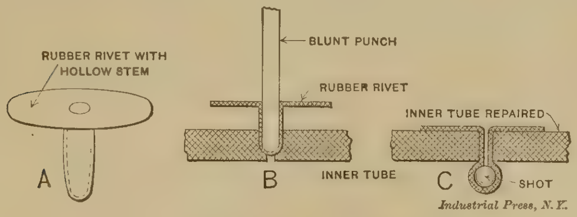


Fig. 4. Repairing an Automobile Tire.

* * *

OLD GEAR CUTTER—HISTORY JOHN STEPTOE SHAPER CO.

In the new shop of the John Steptoe Shaper Co., Cincinnati, Ohio, there is an old gear cutter that seems oddly out of place among the other modern machine tools, but is only kept as a relic, its work now being done by a modern automatic machine.

This cutter is of the type built along in the forties and fifties by the Putnam Machine Co., of Fitchburg, Mass., but whether they were the makers of this particular machine is not evident since there is no maker's name on it. The index plate is fixed upon the vertical work spindle on which were mounted the blanks to be cut, which might be both spur and bevel, since the machine was originally adapted for both. The index plate is about three feet in diameter and contains fully 18,000 holes, all of which were probably laid out, and drilled without the aid of a jig. The outer row contains 500 holes and there are 51 circles in all. The number of holes and the arrangement differ somewhat from the old Putnam gear cutter of the same type illustrated in the October, 1897, issue of MACHINERY. That machine had 468 holes in the outer circle and 52 circles, making a total of 15,690 holes. As stated, the machine is retained as much for its association with the past as any other reason, the John Steptoe Shaper Co. being the oldest machine tool builders west of the Allegheny Mountains. In this connection it may be of general interest to give a short history of the concern which was written at our request:

"The history of the company begins when, in the year 1845 John Steptoe was running a small machine shop in this city, it being at that time the only shop west of the Allegheny Mountains building machine tools. Shortly after starting his shop, Mr. Steptoe took into partnership Mr. McFarland, at the time a patternmaker, and formed the firm of Steptoe, McFarland & Co., and manufactured machines of every description. At first the firm employed but three men, but the business steadily increased and, in 1860, Mr. Nottingham, a foundryman, was admitted to partnership, and Steptoe, McFarland & Co. increased their force and established their own foundry. It would not be out of place here to say that The John Steptoe Shaper Co. still have calls for repair parts for machines built at this time, which means that these machines are still considered worth repairing after forty or fifty years of service. In 1870 the partnership was dissolved and, as the demand for shapers was steadily increasing, Mr. Steptoe, operating under the name of John Steptoe & Co., went into the manufacture of this style of tool exclusively, and produced about fifty machines the first year.

"The business was carried on as above until February 25, 1888, when John Steptoe died. At his death the business came into the hands of George Oetting and Adam Lauther, who had been associated with Mr. Steptoe for some years previous. These parties carried on the business under the same name and on the same lines at the old place, until in the fall of 1902, they found their quarters too small for the steadily increasing business and erected a modern two-story factory on Colerain Ave., in the heart of the machine tool district of Cincinnati

"On January 1, 1903, the business was incorporated as The John Steptoe Shaper Company, and continued the manufacture of shapers exclusively; the management being in the hands of George Oetting as president, and Adam Lauther as secretary and treasurer, and a board of directors. This continued until August, 1903, when Messrs. Oetting and Lauther decided to retire from active participation in the business and disposed of a part of their interests to Messrs. A. L. Rich and O. H. Broxterman of The A. L. Rich Company, and Mr. Alexander Dom, formerly superintendent of the metal department of the Globe-Wernicke Co. for many years. These gentlemen took over the active management with Mr. Dom as president and Mr. Broxterman as secretary and treasurer, and the output to-day is from 500 to 600 shapers annually, ranging from 14 inches to 34 inches stroke. Each machine is manufactured from a complete set of jigs and templates and this system of manufacture, established by many years of experience has led to the training of specialists who produce a maximum amount of work in a minimum amount of time."

We may add that this concern having been in the machine tool business so long, might naturally be thought to have had an important influence on that industry in Cincinnati, and such is the case. Many of the members of the machine tool concerns in that city worked at Steptoe's and some served their apprenticeships there. In an old-time book still in the office of the company may be found the following prominent names: Mr. William Lodge, of the Lodge & Shipley Machine Tool Co.; Messrs. A. L. Smith and James Mills, of Smith & Mills; Messrs. Ed. Gang, William Barker, Thomas Chard, William Oesterlein and others whose product is well known wherever machine tools are used. Mr. Mills was Steptoe's foreman for over twenty years before going into business for himself.

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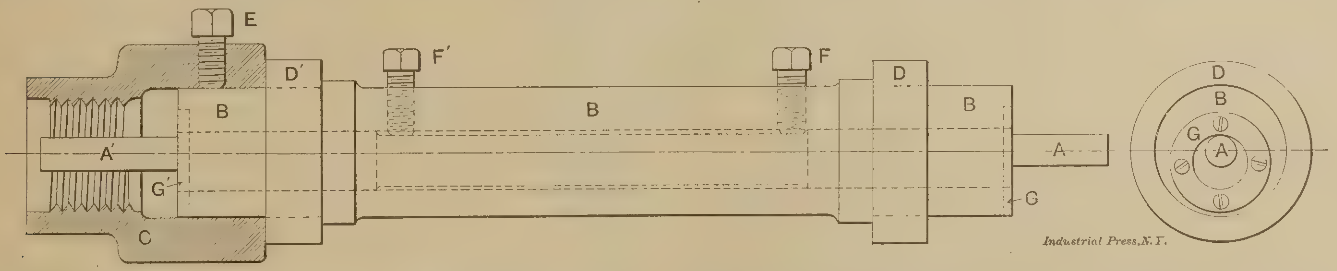
CONTRIBUTED NOTES AND SHOP KINKS.

JIG FOR TURNING BACK GEAR SHAFTS.

C. A. Shafer sends a sketch of a fixture that is used for turning the eccentric ends of back gear shafts. These shafts are first turned and ground straight and are then placed in the fixture for turning the ends *AA'*. *B* represents the jig proper and *C* is a chuck, screwed onto the nose of the spindle, by which the jig is driven. *DD'* are hardened tool steel collars pressed onto the ends of the jig and ground to run in the steady rest. The setscrews, *FF'* hold the shaft in the jig and the screw *E* holds the jig in the chuck.

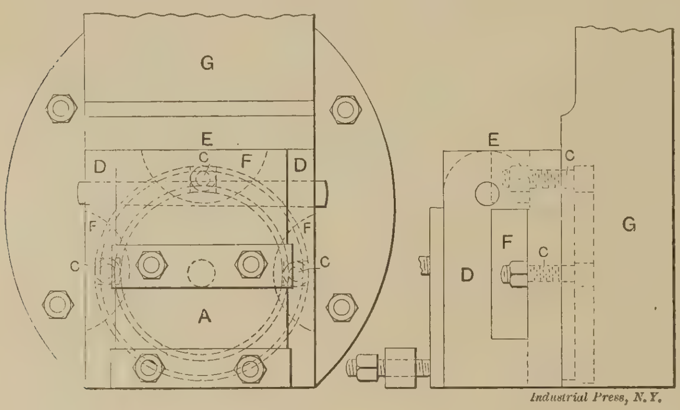


In use, the shaft is placed in the jig as shown, the collar *D* being supported in the steady rest, and the end *A* is turned to the required size, the eccentricity of the jig causing it to be turned eccentric with the main portion of the shaft. The entire jig with shaft in place is then removed from the chuck and turned end for end so that the collar *D'* runs in the steady rest, and the end *A'* is turned in the same manner as *A*.

GG' are tool steel washers inserted in the ends of the jig for the purpose of forming length gages. The end view shows the relatively eccentric positions of the different parts of the jig.

AN IMPROVED FORM OF PLANER APRON.

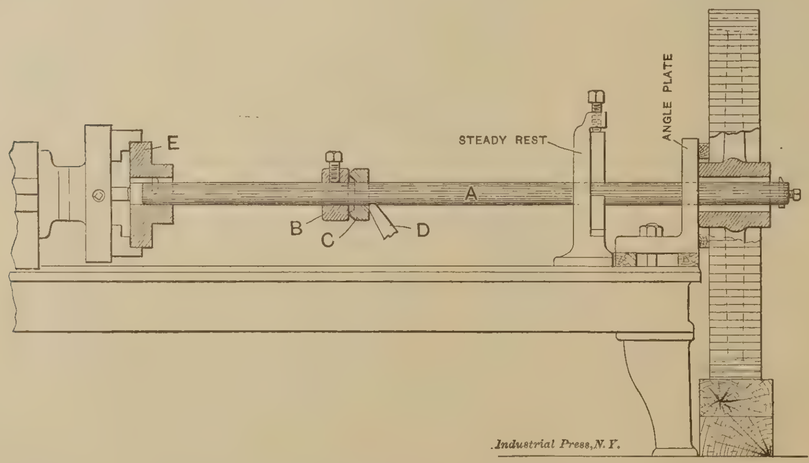
A. D. K. sends a sketch illustrating a form of planer apron which he has found to have considerable advantage over that which is ordinarily furnished. This form is in use by the company with which he is connected and has been furnished, to their specifications, by several of the leading manufacturers of planers. The apron box *D* is cut straight at *E*, doing away with the usual fan-shaped piece with two screws to hold the box in position. On the three sides *F F F* are slots large enough for permitting a wrench to grip the nuts of the bolts *C C C* which travel in a circular T-slot cut in the head *G*. The block *A* is hinged in the box *D* in the usual manner. This style of apron is very stiff and can be swung completely around, which will be found very handy when cutting angles of over 45 degrees and also for jobs of undercutting, such as the guides on the under side of a lathe bed, which can be done without any special fixtures or tools.



Industrial Press, N.Y.

BORING A 42-INCH GEAR ON A 16-INCH LATHE.

A. Putnam sends a sketch of the method by which he was able to bore out the hub of a 42-inch cast gear when the largest machine available was a 16-inch engine lathe. This is a sample of the kind of jobs that are sometimes encountered in remote districts—in this case a Western mining locality—and is a good illustration of the ways and means that some of our ingenious mechanics have to scheme to perform work that would completely phase a machinist of the modern school.



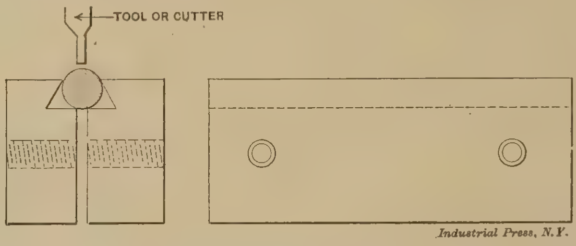
Industrial Press, N.Y.

The casting was bolted to the end of the lathe by means of an angle plate so that its center would be on a line with the center of the lathe, the weight of the casting being borne by means of blocking on the shop floor. The boring bar, *A*, was supported in the steady rest as near to the gear as the angle plate would allow, and as the cuts were light the spring of the bar was not sufficient to prevent obtaining satisfactory results. In the faceplate chuck was placed a shaft coupling, *E*, that chanced to be at hand, bored to the same diameter as the bar, which was a piece of cold-rolled shafting. In the end of this bar was driven a hardened pin which fitted a keyway in the coupling and thus furnished a drive for the bar. In the other end of the bar a boring tool was inserted in the usual manner.

A collar *B* was firmly fastened on to the bar at about the center of its length and against this bore a loose collar, *C*, having its edge turned down to reduce the friction. Against this second collar was placed a round pointed piece of steel, *D*, which was carried in the tool post, so that as the carriage was fed along by the regular lathe feed the boring bar was fed through the gear casting.

SPECIAL VISE JAWS FOR PLANING KEYWAYS.

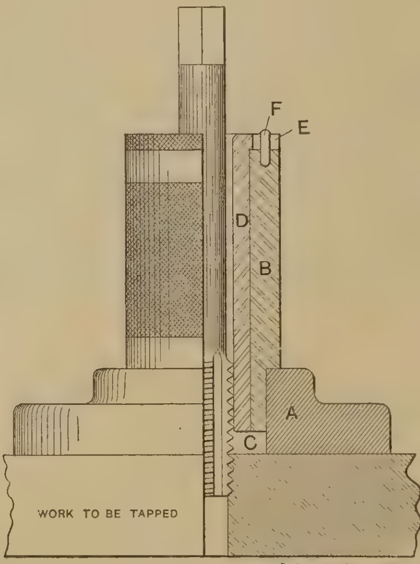
The accompanying sketch, contributed by "A. P.," shows a pair of special vise jaws for use on the shaper or milling machine for holding small, round stock so that it will lie parallel with the vise when planing or milling keyways. The sides of the dovetail should make an angle of about 60 degrees with the bottom, and the thickness and height of the jaws will be regulated by the vise with which they are to be used.



Industrial Press, N.Y.

A TAPPING JIG.

R. A. Lachmann contributes a sketch and description of a combination jig and bushing for tapping holes perfectly true without the necessity of using a square for starting the tap. This jig consists of a base, *A*, made of mild steel or cast iron, the bottom being of any shape that is suited for use on the pieces that are to be tapped. Into this base is fitted the standard, *B*, leaving a clearance space between its end and the face of the base, as at *C*, in order to allow space for burrs thrown out by the tap. Fitting this standard are a set of bushings, *D*, made of suitable sizes for guiding the different sizes of drills that are to be used. These are a good sliding fit in the standard and are all slotted at *E* so as to fit over a small pin, *F*, which prevents them from turning when in use. Any number of bushings may be made for use with a single base, but two or more bases, one for large and one for small sizes, should be provided so as to be better suited to the size of the work. If this jig is held down firmly onto the face of the work it will insure the tap starting straight, and when it is once started the jig may be removed. This arrangement makes it possible to tap holes perfectly straight with but little care and also prevents breakage of taps, especially when using the smaller sizes.



Industrial Press, N.Y.

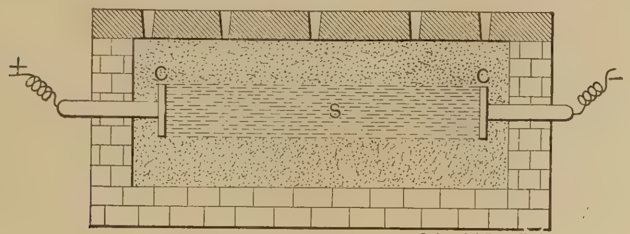
HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

10. A. H. L.: Will you please explain the construction and use of electrical furnaces?

A. An electric furnace, as the name implies, is one in which the heat is produced by the electric current. The general principle involves the formation of an arc between carbon electrodes, and the substance to be treated is exposed to the heat thus produced. Electrical furnaces are used mainly for metallurgical purposes such as the reduction of aluminum and silicon. The sketch shows, diagrammatically, the general arrangement of electrical furnaces which are, of course, more or less modified to suit the conditions. The space in which the reduction takes place is that between the carbon plates, *C C*, which are connected to the electric terminals as shown. In this space is placed the substance to be treated, *S*, while the space above, below and around the sides is packed with powdered carbon or other non-conducting substance. The walls are of fire brick and the cover of fire clay provided with vent holes.



Industrial Press, N.Y.

11. G. A. H.—Kindly tell a reader of MACHINERY how to drill holes in glass.

A.—You do not state what size holes you desire to drill. The best method for drilling holes of medium size is by means of the sand blast and for small holes by the use of a black diamond drill. The black diamond can also be employed for large holes, if several cutting points be inserted in the end of a tube, the tube used as a trepan. As neither of these methods may be convenient for you to adopt, you may have to resort to the old plan of using a very hard drill, lubricated with turpentine. When the drill is about to break through the glass, turn the glass over and drill through from the other side, meeting the first hole. Or if it is not convenient to turn the glass over, clamp a piece of cast iron against the glass, where the hole is to come through, and drill through the glass into the iron. If the iron fits the glass closely the drill will not chip the edge of the hole to any extent in breaking through. It is a good plan to put a sheet of paper between the iron and glass, as this will tend to compensate for any irregularities in the surface of the glass and make better contact with the iron. For holes of medium size you can use a brass or copper tube for drilling, with some abrasive like carborundum or emery to do the cutting. Guide the tube by means of a bushing, so it will run true and stand square with the face of the glass, and rotate the tube at high speed. Allow the abrasive to work under the edge of the tube, and lubricate with water.

12. S. H. S. asks for information regarding the components of the different brands of self-hardening steels and also for an explanation of the Harvey and Krupp processes for hardening steel plate.

A.—1. Most of the self-hardening and high-speed steels are composed of practically the same components, but the percentages of each, and the manner in which they are combined, form trade secrets, which are carefully guarded by the manufacturers. In "Iron, Steel and other Alloys," by Henry M. Howe, the composition of the good self-hardening steels of the present time is given as between the following limits:

Carbon	0.40 to 2.19 per cent.
Chromium	0.00 to 6.00 per cent.
Tungsten	3.44 to 24.00 per cent.
Silicon	0.21 to 3.00 per cent.

The present tendency appears in the direction of replacing the chromium, of steels for high-speed cutting tools, with from 1.25 to 4 per cent. of manganese. 2. Regarding the two processes of hardening plate we quote from the same work: Much of the heavy armor in use is made of nickel steel initially containing so little carbon that it cannot be hardened and remains very ductile even after cooling. The face of these plates is given the intense hardness necessary by being converted into high-carbon steel and then hardened by sudden cooling. Harvey carburized the impact face to a depth of about an inch by heating the plate for about a week to a temperature of 1,200 degrees C. (2,192 degrees F.) with that face strongly pressed against a bed of charcoal. The Krupp process carburizes the impact face by exposing it to illuminating gas at a high temperature. This is decomposed by the heat and deposits on the face of the plate a layer of fine carbon which is absorbed by the steel, as in the cementation process. In either case the face thus carburized is cooled suddenly from a red heat by spraying with iced brine. An intensely hard surface results, decreasing gradually from the face inwards.

13. A. H. G. writes: I desire to make a special study of power and its application, with a view of some day operating and owning power plants. Would it be a good plan to work where I could study and get well enough acquainted with steam engines, their construction, etc., to obtain an engineer's license, and thus get into some power plant? What do you advise as the best course to pursue, both practically and educationally?

A. It is difficult to advise you without knowing what your experience (if any) has been as a machinist, what your technical education has been, and how many years you feel that you can devote to preparation. On general principles, about the best preparation can be obtained in an engine building shop, provided a man is fortunate enough to secure work on the erecting floor and later is able to go out to assist or superintend the erection of engines. If this is not feasible, the next best course to pursue is to at once secure work in an engine room. In any case one should secure all the technical education possible, either by evening or day study; and if you can afford time it would, of course, be desirable to take at least a two-years' technical course at some good school before starting in with the machine shop or engine room experience. A number of schools have good two-year courses that would familiarize one with the various types of steam engines and the principles of steam and its use. There are a great many good books on steam and the steam engine, and many which are not good. For elementary works we can recommend Low's "Power Catechism," price $2.00; Ripper's "Steam," price $1.00; Peabody's "Steam Engine Indicator," $1.50; Spangler, Green & Marshall's "Elements of Steam Engineering," $3.00. For more advanced books, Jamieson's work on the steam engine, price $2.50; Meyer's "Steam Power Plants," $2.00; Peabody & Miller's "Steam Boilers," $4.00. You should also study books on electricity, and we can recommend the following: Swoop's "Lessons in Practical Electricity," $2.00, and Rosenberg's "Electrical Engineering," $1.50, which are excellent elementary works. For advanced books on this subject, Selden's "Dynamo-Electric Machinery," price $2.50, which takes up direct-current; and Selden & Mason's "Alternating-Current Machines," price $2.50.

The Lorenz globoid worm gear, made in Berlin, Germany, is attracting some attention in Europe because of its good efficiency and wearing qualities. From the meager description at hand it appears to be a modification of the Hindley hour-glass type, or perhaps an improvement of same in the matter of manufacture. In the making of the globoid worm gear proper, the worm is first cut by means of a cutting tool swinging in a circle, while the worm also turns about its axis. Lorenz has inverted this process and first forms the wheel teeth with a simple cutting tool, afterward cutting the worm so as to fit the wheel teeth as closely as possible.

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In the August issue of MACHINERY the address of Reinecker Bros., builders of the German worm-milling machine there illustrated, was wrongly given as Coblenz, Germany. It should have been given Gablenz, which is a suburb of Chemnitz, Saxony.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

OESTERLEIN UNIVERSAL DIVIDING HEAD.

Figs. 1 and 2 illustrate a new universal dividing head, for standard and differential indexing, that has just been placed on the market by the Oesterlein Machine Co., Cincinnati, Ohio. This head is arranged to make all divisions from 1 to 380, with the spindle in any position from horizontal to vertical. The differential indexing is obtained by connecting the index plate *A* and rotating it, in a certain ratio, with the crankshaft *B*. This shaft is connected to the spindle by worm gearing and consequently both spindle and index plate revolve in the same or opposite directions in accordance with the divisions that are to be obtained. The principle of differential indexing has recently been thoroughly explained in these columns and its application to this particular head is illustrated in Fig. 2, which shows the arrangement of gearing when set for making 107 divisions.

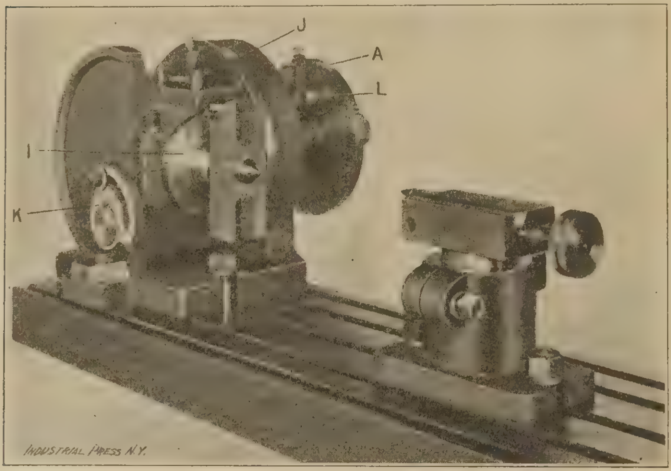


Fig. 1. Oesterlein Universal Dividing Head.

The swivel head is fitted into the frame with taper shank and is held in position by the clamping plate *C* and nuts. For quick spacing a dividing plate *I*, having 24 divisions, is fitted to the front of the spindle, the index pin is operated by the crank *J*, and the whole is enclosed and protected from dirt. When this is in use the worm is disengaged from the spindle by means of an eccentric bushing *K* which can be reengaged by pushing against a stop without adjusting. The crankshaft *B* has secured to its outer part a worm *D* which engages a worm wheel on a shaft running in the bracket *E*. The index plate *A* rides loose on the crankshaft and is connected by proper gearing, for spiral cutting with the table screw and for differential indexing with the wormwheel spindle. The index plate is graduated on its face for the purpose of setting the sector to the desired position by degrees in place of counting the number of holes, a table being furnished for this purpose. For standard indexing requiring delicate adjustment of the spindle, the index plate can be rotated by means of the thumbscrew *L*, placed back of the plate. When the head is used for standard dividing, the bracket *E* may be readily removed. The front end of the spindle is threaded and has a taper hole corresponding to that of the machine spindle. The head swings 11 inches and can be locked without throwing it out of adjustment. The tailstock has a vertical adjustment of 2 inches.

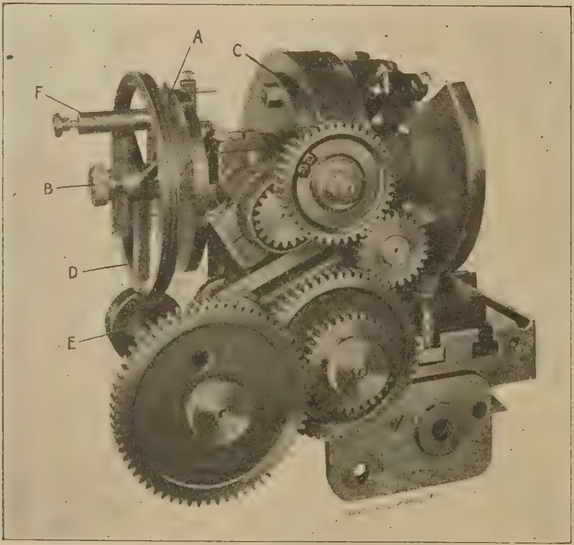


Fig. 2. Oesterlein Dividing Head set for 107 Divisions.

SPECIAL AUTOMATIC MILLING MACHINE.

The half-tone, Fig. 1, illustrates a very interesting machine built by the Newton Machine Tool Works, Philadelphia, Pa., which is a new departure in the milling machine line and is designed to adapt itself to a very peculiar operation. In the work to be milled the cut is very light at the start but increases gradually until near the finish and when the end is reached the cut is very heavy. The machine is also required to stop its feed at an exact point. The milling cutters used on the work are about 6 inches in diameter, and when they reach the finish about one-half of the cutter is in the cut.

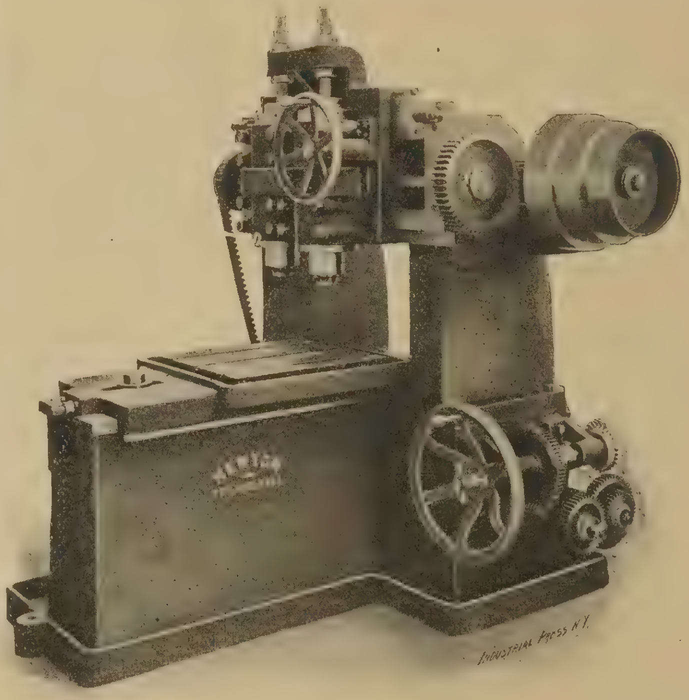


Fig. 1. Newton Special Automatic Milling Machine.

The difficulties of making any automatic trip stop that will operate at an exact point will be readily appreciated, and it is quite a complication of feeds that would be required to produce the result desired, that is starting off with a fast feed and gradually reducing until finally coming to a dead stop at the finish. So the machine was designed to employ a crank feed by which the required results are very satisfactorily accomplished.

Primarily this machine is a heavy vertical spindle miller having two spindles, both of which are mounted on one saddle and have an adjustment vertically for convenience in setting to the work. The ends of the spindles are threaded so that cutters can be fitted to the nose, but only one spindle is in operation at a time, as one is used for the roughing cutter and one for the finishing. When the head is over against one of the stops the roughing cutter is in the center, and when the roughing cut is completed, the saddle, carrying both spindles, is moved across the rail by hand wheel to the other stop, which brings the finishing cutter in exactly the same position.

The feed of the machine, which is more clearly illustrated in the drawing, Fig. 2, is through a silent chain drive and two sets of gearing with a shove pin to give a quick change of feed from the roughing to the finishing cut. Driven through a train of gearing is a large wormwheel which acts as a crank, carrying the connecting rod which is coupled to a crosshead on the front of the carriage, this crosshead having a screw on the front end, for convenience in adjusting carriage and connecting rod. It will be seen that this feed must necessarily be at its fastest when the crankplate is on one quarter of a turn, (the position shown in the drawing) and this will gradually decrease until it gets to the turning point when it starts to reverse, thus producing the result which is necessary on the work. The length of feed is varied by shifting the crankpin across the face of the crankplate, a screw and nut connection being provided for this purpose. As the material to be milled is steel the entire machine is set in a pan to provide for the heavy lubrication that is necessary on this work.

FELLOWS GEAR SHAPER WITH ELECTRIC MOTOR DRIVE.

The accompanying photograph illustrates the Fellows gear shaper as it has recently been arranged for individual motor drive. The only change necessary was the casting of a plate to span the pillow blocks of the regular driving gear to afford a support for the motor, and the substitution of a sprocket wheel for the cone pulley used with belt drive. With these alterations a standard form has been evolved as shown in the illustration. A 5 horse power, semi-inclosed type motor manufactured by the Crocker-Wheeler Co., Ampere, N. J., supplies the power, transmitting it, with a reduction in speed, through a Renold silent chain to the spindle which normally holds the cone-pulley. The speed is further reduced through either of the two regular gear combinations which are used alternately, making two speeds possible mechanically. In addition the motor is supplied with current on the Crocker-Wheeler four-wire multiple voltage system giving it six independent speeds, and with the use of resistance twelve intermediate ones. The upper ten of the motor's eighteen speeds constitute its working range, within which, through the faster gear combination it drives the ram at from 45 to 94 strokes per minute, or with the slower gear combination, 20 to 43. The lower eight available motor speeds may be used to extend the range down to six strokes per minute, though 20 is the minimum in ordinary practice. The machine is capable of cutting external gears up to 36 inches in pitch diameter by 5 inches face and internal gears 28 inches in pitch diameter by 3 inches face, allowing any diametral pitch up to four.

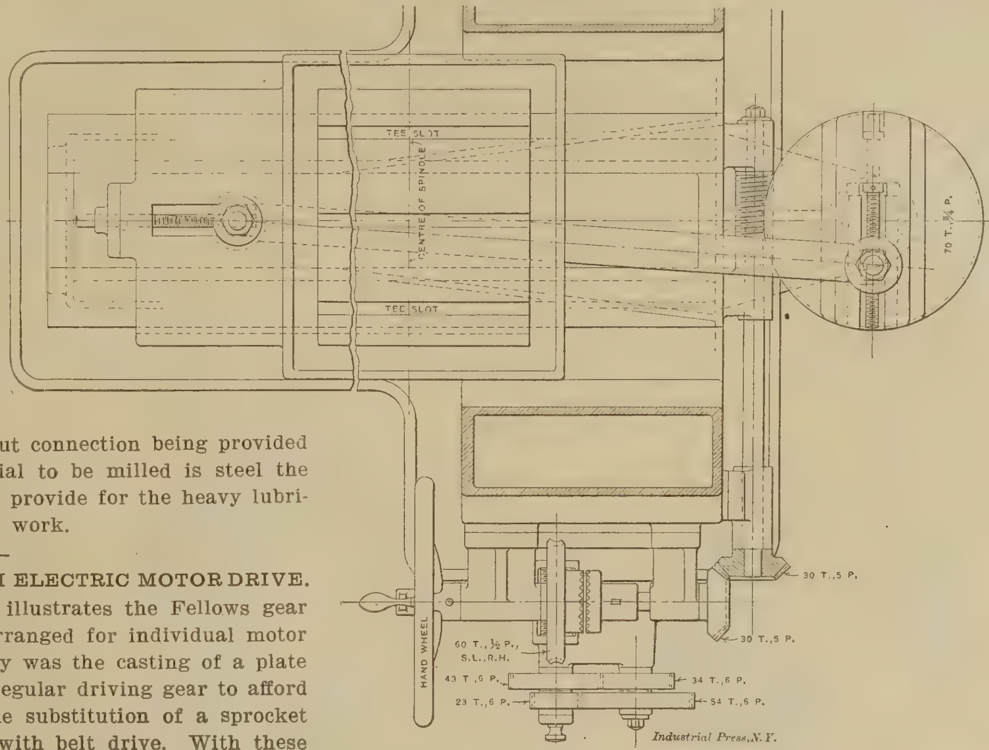
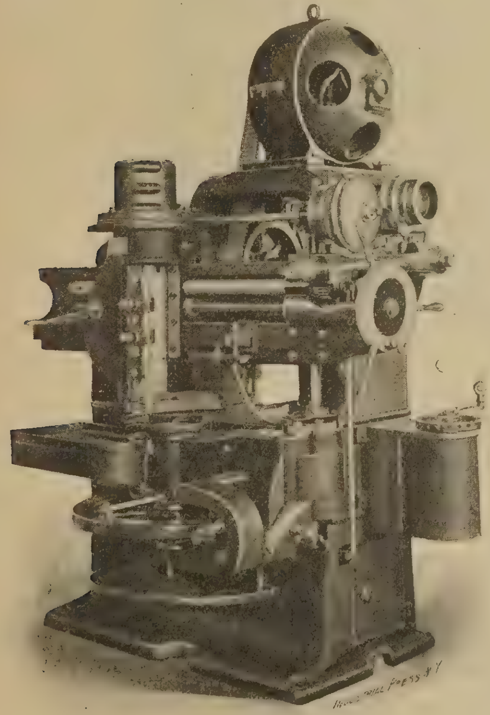


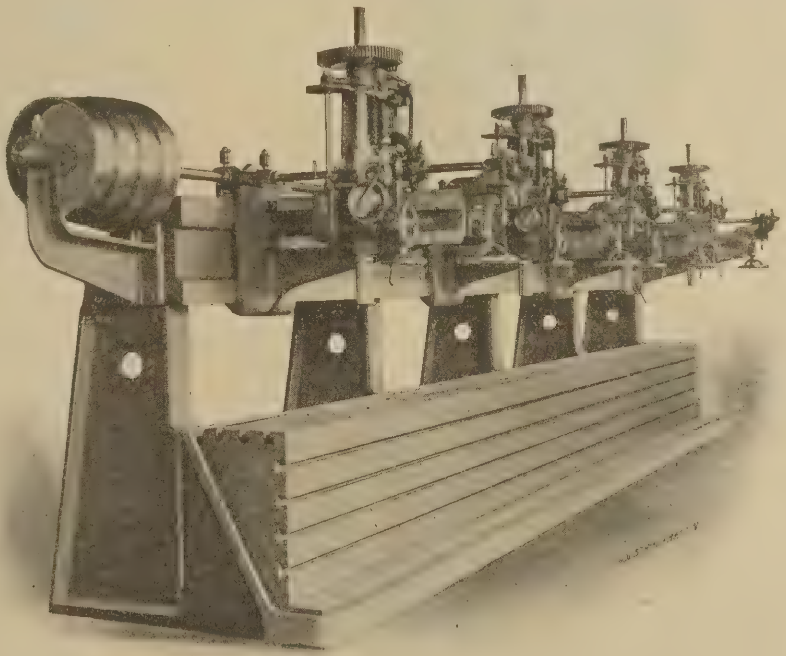
Fig. 2. Detail of Feed for Special Automatic Milling Machine.



Fellows Gear Shaper with Motor Drive.

LOCOMOTIVE FRAME DRILL.

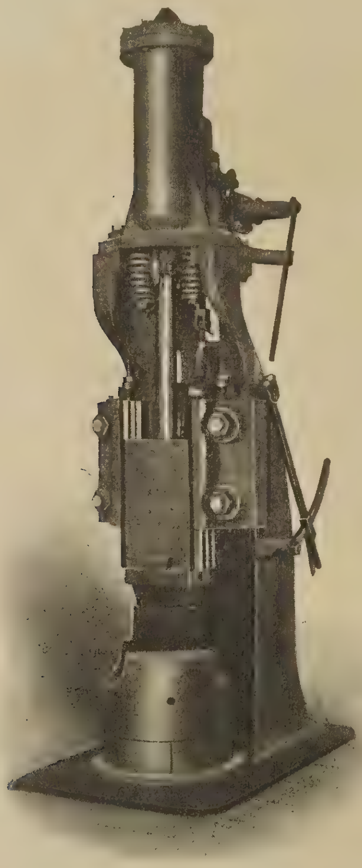
The four-spindle drill shown in the accompanying halftone has been designed and built by the Bickford Drill & Tool Co., Cincinnati, Ohio, from specifications submitted by the Locomotive and Machine Co., Montreal, Canada. This machine is used for drilling, reaming and tapping the sides and edges of locomotives frames up to 27 feet 3 inches between holes.



Four-spindle Locomotive Frame Drill.

The arms are made in pipe section and are adjustable on the rail by either hand or power. One of these is made to rotate through an angle of 30 degrees. The spindles have eight changes of speed ranging in geometrical progression from 49 to 120 revolutions per minute and are provided with both hand and power feed, quick advance and return, safety stop, automatic trip, dial depth gage, and hand lever reverse. The back gears are located on the head, bringing the power directly to the work and may be engaged, disengaged, or thrown out of service while the machine is running, the operator not having to reach the shifter in order to stop the spindle.

The depth gage answers a double purpose since, in addition to its use by the operator for reading all depths from zero—thus obviating the necessity of scaling or calipering—it supplies a convenient means for setting the automatic trip, the graduations showing exactly where each dog should be set in order to disengage the feed at the desired points. The automatic trip operates at as many different points as there are depths to be drilled at one setting of the work and in addition it leaves the spindle free, after any intermediate tripping to be advanced, raised, or traversed its full length without disturbing the setting of the dogs. It also throws out the feed when the spindle reaches its limit of movement.



Eight Hundred pound Double-acting Steam Hammer.

The feeding mechanism furnishes eight rates of feed ranging in geometrical progression from .007 to .064 inch per revolution of the spindle, all of which are instantly available without shifting a belt or operating under a feed of unnecessary fineness. The tapping mechanisms are located on the head and are fitted with friction clutches operated by levers the handles of which extend around under the arms within convenient reach of the operator. The spindles have a vertical adjustment of 17 inches and operate over an area of 2 feet 4 inches wide by 27 feet 3 inches long. The table has a width of 18 inches and is 29 feet in length. This machine weighs 49,000 pounds and is driven by a 5-inch high-speed double belt.

EIGHT HUNDRED POUND DOUBLE-ACTING STEAM HAMMER.

The new double-acting steam hammer which is illustrated herewith has recently been placed upon the market by the Bethlehem Foundry & Machine Co., South Bethlehem, Pa. The piston rod and head of this hammer are made from one solid steel forging and the ram is a steel casting, running on V-shaped guides which are adjusted for wear. The piston head can be raised above the top of the cylinder without removing the rod from the ram, permitting an examination or replacing of the rings. The piston is steam cushioned on top to prevent it from striking the cylinder head. The valve motion is automatic and of simple construction, employing a balanced valve of the piston type which moves very easily. It is controlled by a single hand lever by means of which the operator can strike single blows of any desired force from the lightest to the full capacity of the hammer, or cause the hammer to strike a succession of blows automatically. The steam supply is controlled by a balanced throttle valve by means of a hand lever. The steam cylinder of this hammer is 8¼ inches in diameter and the stroke 24 inches. The falling parts alone weigh 800 pounds while the weight of the hammer complete is 14,000 pounds.

BULLARD BORING AND TURNING MILL.

Fig. 1 of the accompanying illustrations shows a new form of boring and turning mill that has just been brought out by the Bullard Machine Tool Co., Bridgeport, Conn. This machine regularly has one fixed turret head and one swivel head, although two swivel heads can be supplied if required. The machine is driven from the side so as to permit the application of a constant or variable speed motor at any time that it may be desirable. The cross rail heads are operated by power, which is obtained by driving the vertical feed rods at a high constant speed from the overhead shaft, and at a variable speed through an independent feed box on the bed at the lower end of the rods. A lever which is movable in both directions from its normal position, operates a clutch mechanism in the bevel gears of the overhead bracket, giving the vertical rods a movement in either direction as desired, and driving the cross rail heads through the regular feed brackets on the back of the rail. When this lever is in its normal position the overhead clutches are disengaged and the feed works of the lower brackets are automatically engaged with the vertical rods. This makes it impossible for the quick traverse to become engaged at the same time as the feed works, and obviates the necessity for the operator to disengage the feed works before operating the quick traverse.

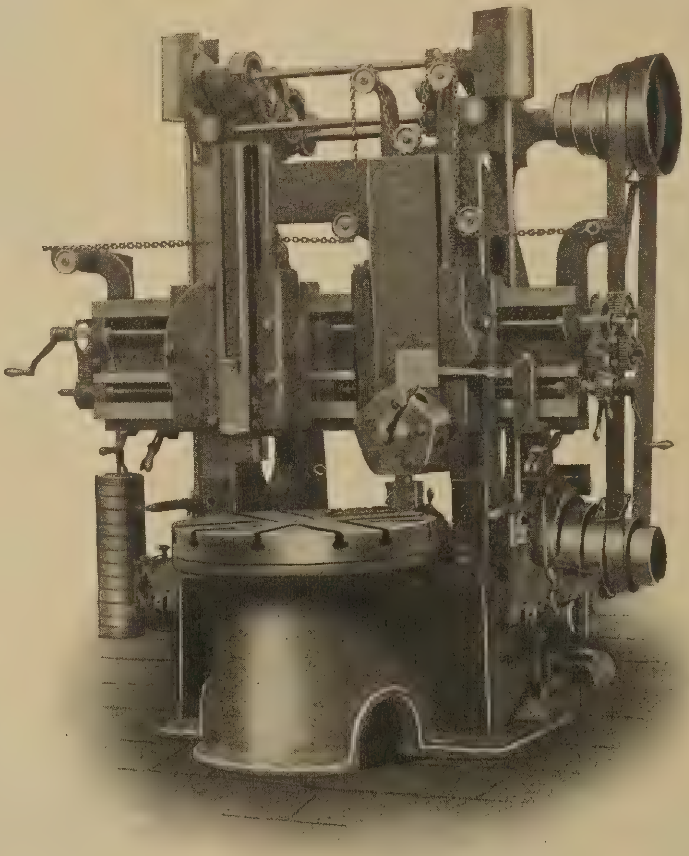


Fig. 1. Bullard 42-inch Boring and Turning Mill.

The feeds are positive, having ten changes ranging from

1-32 to ¾ inch horizontally, and from 1-50 to ½ inch in angular and vertical directions. In the cross rail bracket on each head the feed is engaged and disengaged by a toggle friction, operated by a hand lever, which not only provides a quick means of engaging and disengaging the feed but also answers for a safety device to prevent accidents in case of the heads being run together, either by the quick traverse or by the feed mechanisms. The right-hand head is provided with screw cutting gears that are entirely independent of the feed gears, so that it is possible to bore out a hole with as fine feed as required and then, without changing any gears, immediately chase the hole with any thread for which the machine is geared. The turret head is arranged to cut all standard threads from 2½ to 12 per inch.

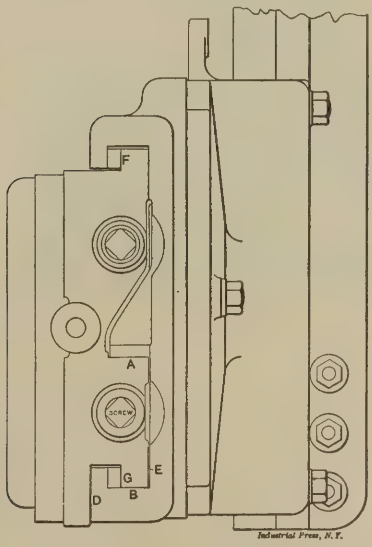


Fig. 2. Cross Rail of Bullard Boring Mill.

The design of the cross rail, shown in Fig. 2, shows the method employed for maintaining the alignment regardless of the severity of the duty required of the machine. The length of the bearing surfaces on the rail has been increased and the width narrowed, the horizontal alignment being obtained on surfaces *A* and *B* with the screw located as near central as possible. The saddle is gibbed back against the rail, receiving its thrust on the surface *D*, and does not bear on the surface *E* but is gibbed between surfaces *F* and *G*. It is of the square-locked type having no loose joints, taper steel gibs being used for taking up the adjustment. This same type of bearing is also employed for maintaining the alignment of the cross rail with the right hand upright, the left hand upright merely acting as a support.

The belt shifter enables the operator to shift the belt from one step to another without injuring his hands even when the machine is running at full speed. A foot brake is applied directly to the large step of the lower cone pulley and brings the table to a stop at any desired point. The counterweighting of the head is accomplished by passing the chain back of the center, where it will be out of the way of any tackle that is used for loading work on the table, and as the turret tools are likely to vary considerably in weight, small weights are employed for increasing or decreasing the counterweight.

The table spindle is of the regular type, the vertical thrust being taken on the angular bearing, which is 24 inches in diameter, and is entirely immersed in oil. The table has parallel slots for the reception of the Bullard spiral jaw chuck but a combination chuck can be fitted if required. The total weight of this machine is 14,300 pounds net.

SPRINGFIELD AXLE BORING LATHE.

Owing to the ever present liability of steel forgings to contain concealed flaws or "pipes" the plan has been adopted by the Pennsylvania Railroad of boring a two-inch hole completely through the center of all locomotive axles, thus affording a means of examination whereby any existing flaws may be detected. Such practice will be seen to present a considerable problem in deep hole drilling, as it must of necessity be accomplished in the least possible time. For this purpose, as well as for general bar and spindle boring, the Springfield Machine Tool Co., Springfield, Ohio, have designed and built the boring lathe illustrated in the half-tone herewith.

This machine has a capacity for boring holes from 1 to 4 inches in diameter, in bars up to 11 inches in diameter, and of any length up to 84 inches. The spindle is a large cast-iron shell having a three-jaw universal scroll chuck secured to a flange that is cast integral with the spindle. This construction will be clearly seen by reference to Fig. 2, which is a partial section through the spindle and driving cone. The bar to be bored is held in the chuck and, passing through the spindle, is supported at the other end by adjustable screws furnished for the purpose. The driving cone is mounted on an auxiliary shaft, placed above the spindle, to which it is connected by means of a pinion which engages with a gear cut into rear flange of chuck. Back gears are provided which, in connection with two speeds obtained from the countershaft, give sixteen boring speeds arranged in geometrical progression.

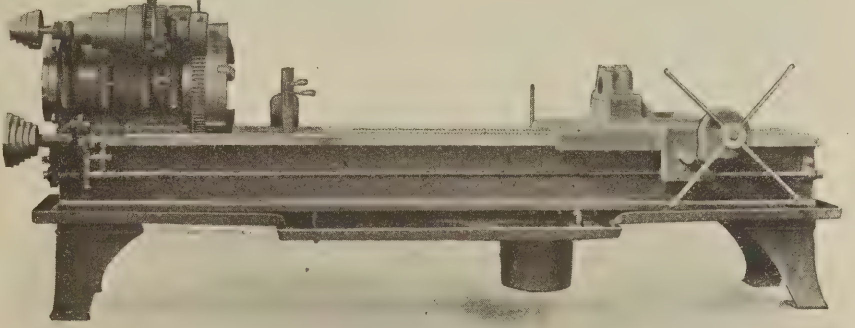


Fig. 1. Springfield Axle Boring Lathe.

A long carriage, which supports the drill and boring tool, slides on large V-s and is gibbed its full length to the outside of the bed. Two racks are provided, one on each side of the top of the bed, into which the pinions mesh, so that the feed is more steady than it would be if but a single rack and pinion, on one side of the bed, were used. The carriage may be rapidly moved into any position by the pilot wheel and the power feed is engaged with a powerful friction. With a five-step cone on the driving shaft, which makes 3¾ revolutions to one of the spindle, motion is transmitted to a feed cone geared to the feed rod in such manner that two speeds may be obtained from each cone step, thus giving ten rates of feed, ranging from .0005 to .01 inch per revolution of the spindle.

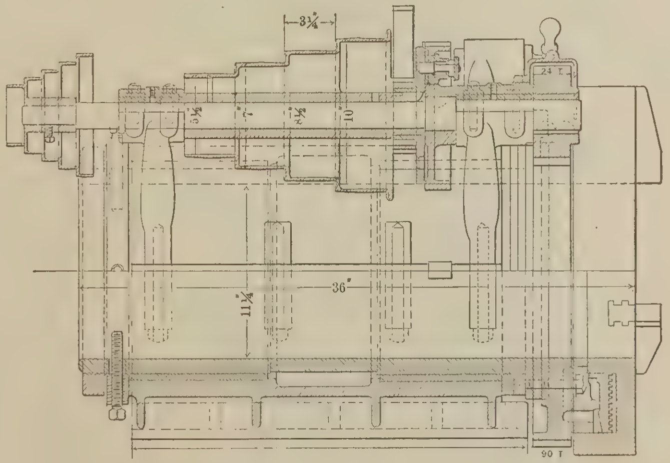
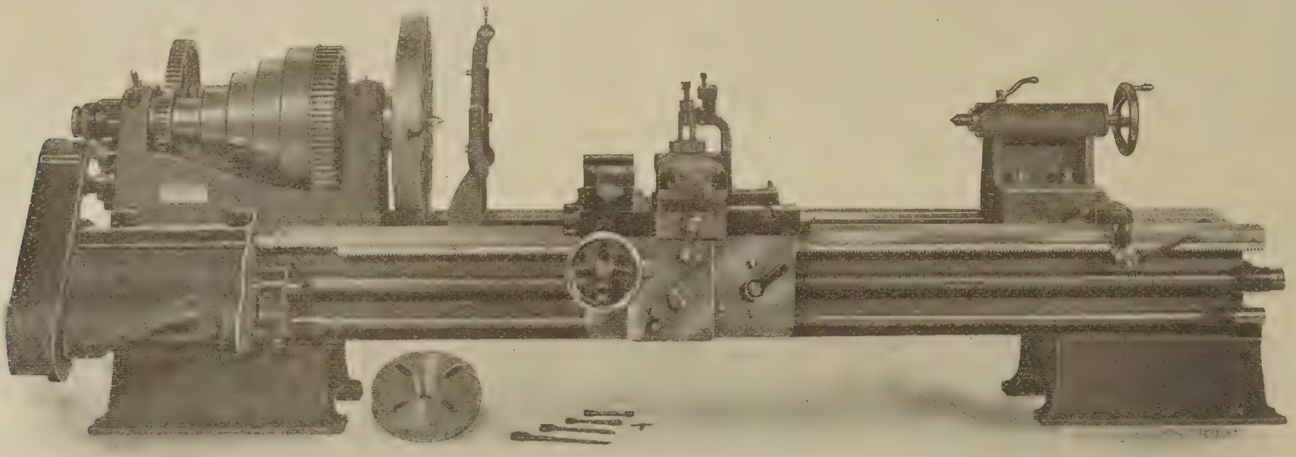


Fig. 2. Section through Head of Axle Boring Lathe.

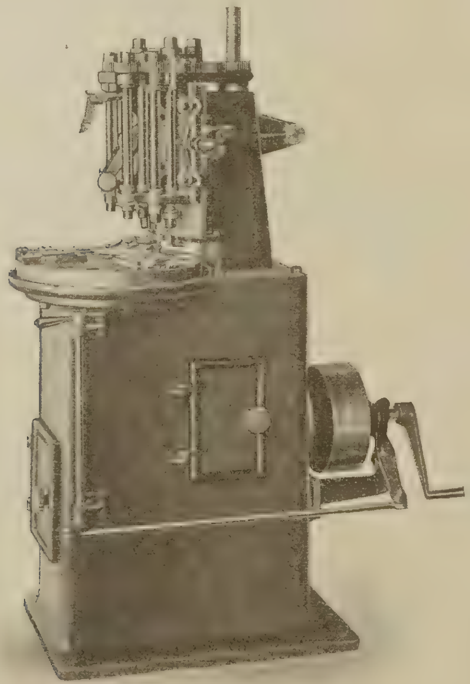
A force pump is supplied for lubricating the cutting edges of the drill and the machine is surrounded with a pan having an oil reservoir of ample capacity so that the lubricant has sufficient time to cool before it is used again. A guide is furnished for centering the tools at the beginning of the hole, but as soon as the hole is started this is swung out of the way.

NEW 32-INCH BANK-GEAR ENGINE LATHE.

The half-tone presented herewith illustrates a new 32-inch lathe just brought out by the Prentice Bros. Co., Worcester, Mass., which embodies several new and improved features of construction as relates to the apron, bank of feed gears and the method of putting on the feed rod and lead screw. As will be seen in the cut, the feed rod and lead screw stop at the end of the gear box. A bank of gears is mounted on a shaft, independent of either the feed rod or the lead screw but so arranged that it may be connected with either by means of a sliding gear, thus making it possible to cut 48 pitches, from ½ to 24, or to give 48 feeds. A tumbler gear connects the shaft, which takes the power from the head end of the lathe to any one of the gears in the cone. The different pitches are obtained by sliding the tumbler along, as indicated on an index plate, giving 12 changes thereby. There are, on the head end of the lathe, four other gears which can be changed and these in combination with the cone, make 48 pitches, there being 38 changes without any repetition. This lathe has a double apron and bevel gear drive and there is a device which obviates any chance whatever for both the feed and screw gearing to become meshed at one time.



Thirty-two inch Prentice Bank-gear Engine Lathe.

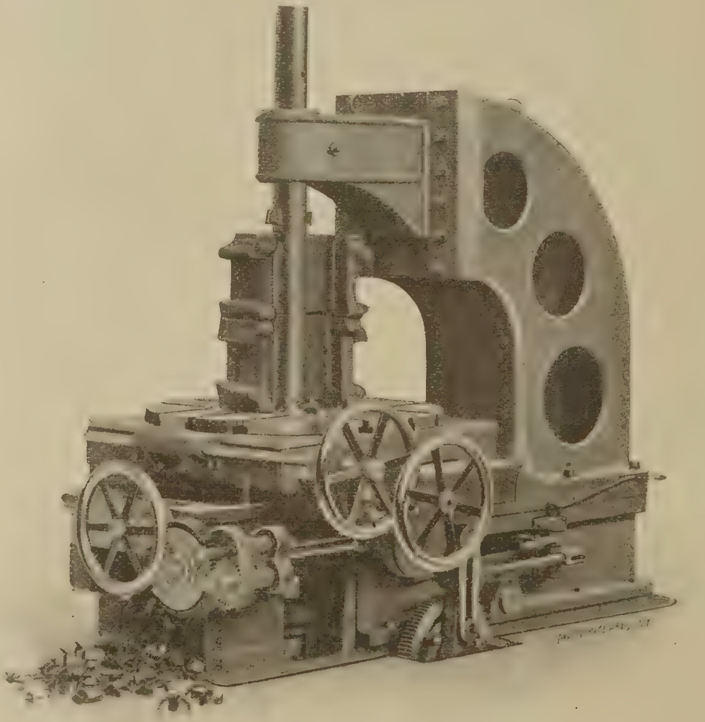


Rotary Platen Multiple Drill.

ROTARY PLATEN AUTOMATIC MULTIPLE DRILL.

The National Automatic Tool Company, Dayton, O., have just placed on the market a new machine for multiple drilling which is designed to meet the demand for a drill press of smaller capacity than their automatic turret drill which has previously been described in these columns. This drill performs practically the same class of work as the turret drill, but has only two clusters of drills instead of six. From four to ten spindles may be used in each cluster, and each spindle is adjustable in any direction. The idea of the double cluster is that one set of drills will drill and the other set may be used to ream or counterbore the same holes, or where two holes are drilled in close proximity, one hole is drilled with the first cluster and the next one with the second cluster.

The feed table, or platen, revolves automatically and may be indexed from two to six times. From three to six jigs may be mounted on the platen, and the operator, standing in front of the machine, simply loads and unloads the jigs as the platen revolves. The operation is thus continuous, two jigs being worked while the others are being loaded. The drills are automatically depressed to meet the work and the machine may be stopped instantly at the will of the operator. The spindles are gear driven, and each drill runs at its own proper cutting speed. The machine is adapted for drilling in steel, cast iron, brass or wood, three changes of feeding speed being provided. It is built in two sizes, the smaller having a capacity for drills from No. 60 wire gage up to ⅜ inch, and the larger taking drills from No. 60 wire gage up to ¾ inch.



Thirty-inch Draw-stroke Slotter.

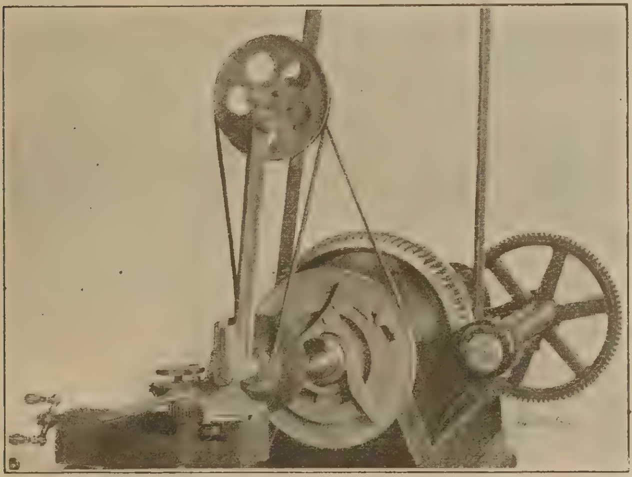
THIRTY-INCH DRAW-STROKE SLOTTER.

The accompanying half-tone illustrates a heavy slotter, acting on the draw-stroke principle, which, although originally designed for machining steel locomotive driving boxes, is equally adapted to a great variety of other slotting of castings and forgings, especially in long, deep holes, which cannot be reached by the ordinary type of slotter. It is also adapted to shaper work on the ends of long pieces of such irregular shape that it is impossible to chuck them in a planer, and in addition to these uses, it makes a very handy keyseater. The working table, which is 38½ inches in diameter, is placed low so as to be convenient to the operator. Full automatic feeds in all directions are provided, all of which are readily engaged from the front of the machine, all hand feeds being operated from the same position. The length of feed is adjusted from the right hand side of the machine.

The ram is rack and pinion driven through a heavy train of gearing and is counterbalanced. The reverse is accomplished by shifting belts, which are very wide and shift freely. The bar carrying the cutting tool can be of any shape or size up to 4½ inches in diameter, and one bar may be readily replaced by another by the substitution of suitable bushings. The support of the bar is very rigid, as it is fixed at one end by clamping in a long bearing in the driving ram, is supported by a bushing in the lower table directly below the work, and in a bushing in the upper arm directly above the work. The tool relief on the return stroke is secured by means of a clapper box in the cutter bar. This slotter is the product of Baker Brothers, Toledo, Ohio.

A NEW LATHE CENTER GRINDER.

One of the constant trials of the machinist is the necessity of keeping the lathe centers in good condition, and many styles of grinding attachments have been devised for accomplishing this end. The requirements of any such a device are, that it shall be simple in construction and easily placed in position and that it shall be of suitable mechanical construction to insure smooth grinding at an accurate angle. These conditions seem to have been met in the new center grinder illustrated herewith, which is the product of the Mueller Machine Tool Company, Cincinnati, O.

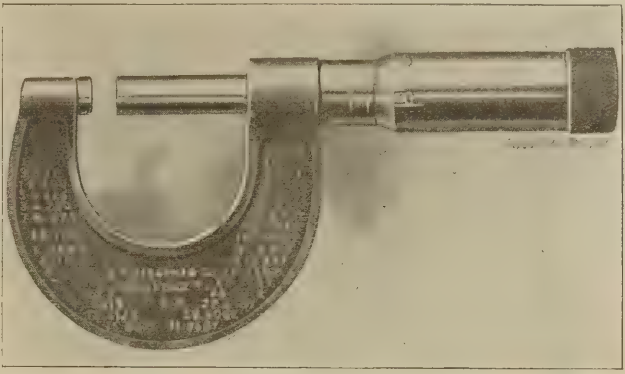


Mueller Lathe Center Grinder.

The pulley by which this attachment is driven is clamped to the nose of the spindle by a universal friction clamp so that marring or scoring of the spindle is entirely avoided. The base of the grinder is bolted to the tool block, its spindle being set parallel with the axis of the lathe by placing it between the lathe centers while setting it in the tool block. The upper part of the attachment slides on the base at an angle of 30 degrees with the axis of the lathe, and this upper part, carrying the wheel, is moved back and forth by a hand lever through the medium of a pinion and rack. The spindle is tapered for adjustment and is driven at about 1,600 revolutions when the lathe spindle is running 250 revolutions per minute. The driving is accomplished by two round belts, provision being made in the intermediate wheel stand for adjusting them to the proper tension. This attachment is also useful for light circular grinding, when it is then operated from an overhead drum. A rest attachment renders it available for sharpening saws, cutters, small drills, etc.

A NEW STYLE OF MICROMETER CALIPER.

The J. T. Slocomb Company, Providence, R. I., have just added to their line of micrometers and shop tools the one-inch micrometer shown in the photograph herewith. This instrument has a polished frame of I-section, and the space within the ribs is utilized for a full table of decimal equivalents—eighths, sixteenths and thirty-seconds appearing upon one side and sixty-fourths upon the other. These figures are raised from the surface by a new process, in a hydraulic press, a pressure of about three hundred tons being required. They therefore stand out very clearly, and together with the ribs form a very convenient finger hold as well as bearing the reference table of equivalents where it can be most easily referred to. It has also been noted that the compression of the steel makes the frames very materially stiffer. The other features of the instrument are practically the same as are embodied in the regular line of micrometers manufactured by this company.



New Style of Slocomb Micrometer.

A NEW BALL AND SOCKET HANGER.

A shafting hanger of new and novel design has been brought out by the Bantam Mfg. Co., makers of roller and ball bearings, Bantam, Conn. The hangers are planned to accommodate conditions met with in nearly all cases where shafting is employed—namely, shafting out of line, either through the settling of the building or through unequal belt pull tending to deflect the shafting between the hangers.

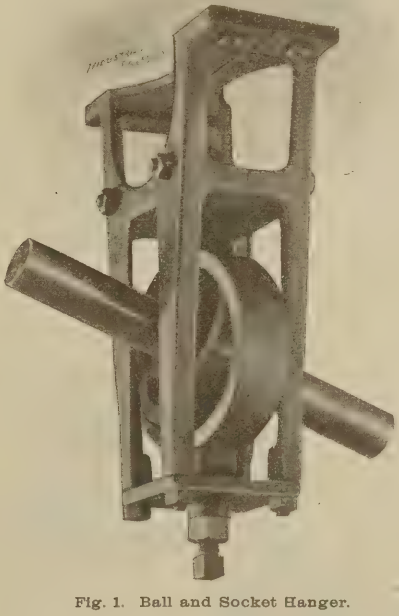


Fig. 1. Ball and Socket Hanger.

In Fig. 1 is a view of a hanger as it appears when suspended from the ceiling and the inclination of the short shaft which projects through the bearing shows to how great an extent this bearing can accommodate itself to the angularity of the shafting. The design of both the hanger and the bearing is along original lines. The frame consists of two main castings bolted together, and there are an upper and lower horizontal plate for the support of the bearing. A ball bearing is used and the parts of the bearing are contained within a ball-and-socket joint which allows the inclination of the shaft shown in Fig. 1. The ball-and-socket joint is formed by means of two rings, one of which is spherical outside and the other spherical inside. The outer ring is split in a vertical plane so that it can be fitted over the inside ring, and it has two trunnions by which the ring is pivoted to the upper and lower plates mentioned above. The joint in this ring passes through the trunnions, and the two halves of the ring are held together by two caps, one of which fits over each trunnion. These caps are held in place by setscrews. One of the setscrews is seen projecting below the hanger in Fig. 1, while the upper one passes through the upper horizontal plate. The runways for the balls are hardened and ground. The ring forming the internal runway of the ball bearing is bored large enough to accommodate a taper bushing which fits over the shaft, and by changing these bushings, which can be done very easily, each countershaft is adapted to several diameters of shafts without making any further change, and thus it is not necessary to have many sizes of hangers to accommodate all sizes of shafts. The manufacturers now make three sizes of hangers, which are sufficient for any ordinary plant.

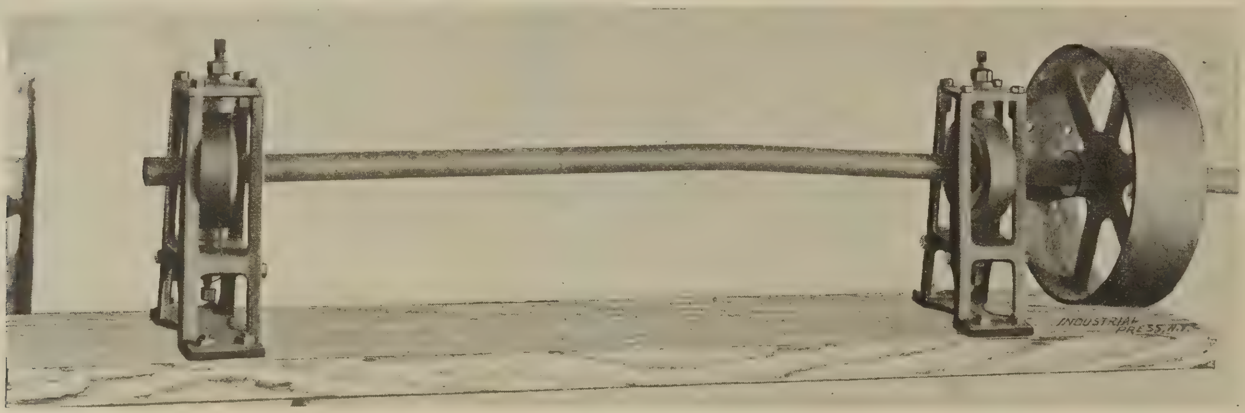
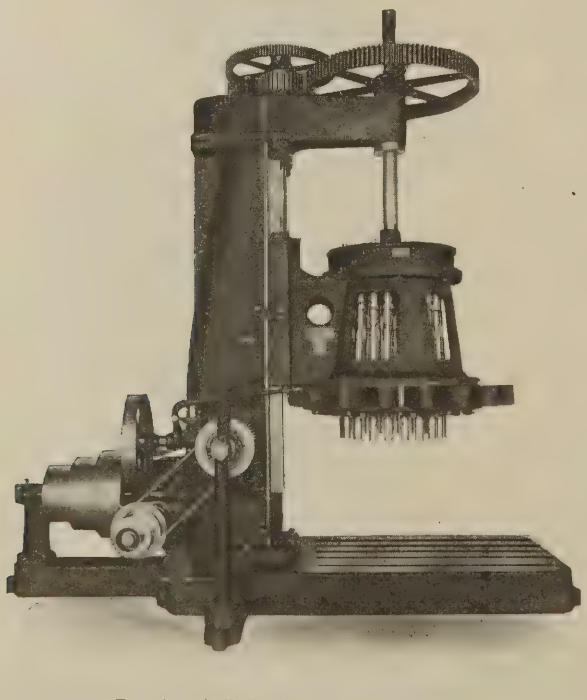


Fig. 2. A Pair of Ball and Socket Hangers being Tested with a Crooked Shaft.

Fig. 2 shows two of the hangers mounted on a plank to test their ability to operate smoothly when supporting a very crooked shaft. A 1 7-16-inch shaft was bent as shown and was operated at 180 revolutions per minute with ease by means of a twine serving as a belt to drive the pulley. The conditions of alignment of the shaft were so bad that a belt would not stay on the pulley. We have received a photograph taken while this shaft was running, which, however, is not reproduced.

HIGH SPEED ADJUSTABLE MULTIPLE DRILL.

The accompanying half-tone illustrates a new twenty-spindle multiple drill that has recently been designed and built by the Baush Machine Tool Co., Springfield, Mass., for drilling valves at a high rate of speed. The machine is driven by a 7-inch belt and is provided with roller and ball bearings. The head is moved up and down on the post by a screw operated by an automatic feed and stop device, which makes it very easy to handle and rapid to operate, besides relieving the workman of much unnecessary handling. A quick return is also provided.

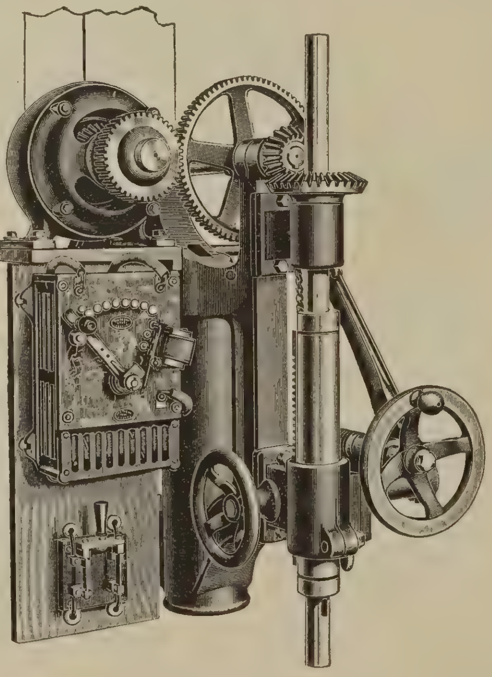


Twenty-spindle High-speed Multiple Drill.

High-speed tool steel drills are used in these machines with speeds ranging from 500 revolutions per minute for ½ inch drills to 175 revolutions for 1¾ inch drills, and with corresponding feeds of 3¼ and 1¾ inches per minute respectively. These speeds are based on a peripheral speed of 65 feet per minute. The feeds increase from 1 inch of feed per 150 revolutions to 1 inch of feed per 100 revolutions. The Bocorselski joint is used throughout for transmitting motion from the central spindle to the different drills. The total weight of this drill is about 23,000 pounds.

ELECTRICALLY-DRIVEN OVERHEAD DRILL.

A new electrically-operated, overhead drill has just been brought out by Boynton & Plummer, Worcester, Mass., which is designed to be placed on a beam or post so that work of any diameter may be brought under it. The spindle of this drill is counterbalanced by means of a weight in the frame, and has a vertical motion of 11½ inches. Both lever and worm feeds are provided, the worm feed being instantly engaged or disengaged by a small lever which raises the worm or lowers it into mesh.

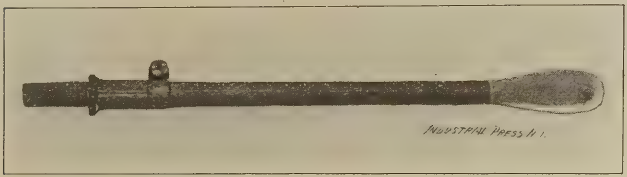


Overhead or Post Drill.

A shelf is attached to the side of the frame and on this is mounted a 220-volt, ½-horse power motor built by the Northern Electrical Mfg. Co., Madison, Wis. This runs at a speed of 900 revolutions per minute and carries on its shaft a rawhide pinion which meshes with the driving gear on the drill. Bevel gear connections, between the driving gear shaft and the splined spindle, give a maximum speed to the drill of 270 revolutions per minute. The illustration shows the arrangement of rheostat and switch which are so placed as to be convenient to the operator. The same drill may, if desired, be furnished with belt-driving pulley and the motor omitted.

THE DIAMO-CARBO EMERY WHEEL DRESSER.

One of the most expensive requisites of the tool room is the black diamond which is required for truing and shaping emery and other grinding wheels. In order to afford a means for doing this with a less expensive tool the Desmond-Stephan Manufacturing Co., Urbana, Ohio, have placed upon the market the emery wheel dresser which is illustrated below. This consists of a brass or copper tube which is filled, by a vitrifying process, with an abrasive of sufficient hardness to cut emery or carborundum wheels. On the outside of this tube is an adjustable collar, which is moved so as to form a back stop over the emery wheel rest. The dresser is then passed lightly over the surface of the wheel, which it trues or shapes to any desired form.

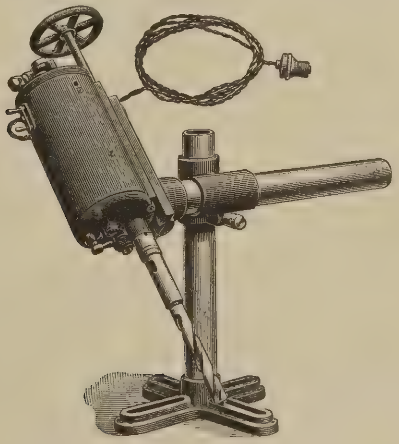

INDUSTRIAL PRESS N.Y.

Diamo-Carbo Emery Wheel Dresser.

PORTABLE ELECTRIC "SCOTCH" DRILL.

The accompanying engraving of a portable electrically-driven Scotch drill appeared in this department in the November number and is reproduced herewith, because the engraving was inadvertently placed with the description of another tool, without suitable title, so that it was not clear who manufactured the drill. This drill is made by the Hisey-Wolf Machine Co., Cincinnati, O. It has a capacity for holes up to ⅞-inch diameter, and a feed of 7 inches by the hand wheel.

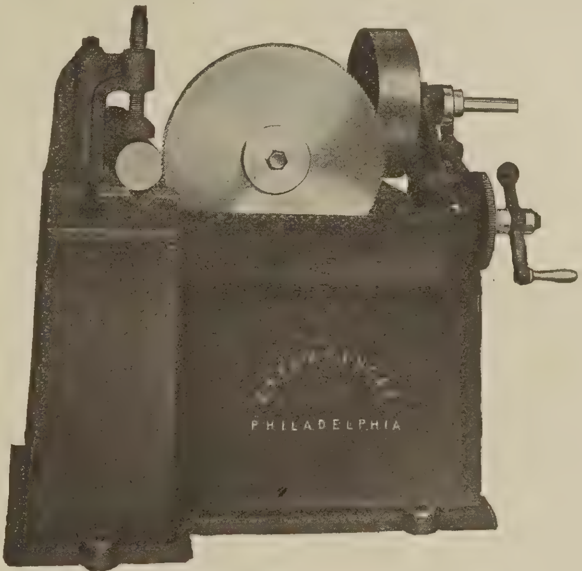
The adjustable bracket upon which the drill is mounted has a movement of 20 inches in any direction, making the machine universal. The drill has two speeds, the power being obtained from any incandescent lamp circuit where direct current is employed, the motor being wound for 110 and 220 volts. The motor is inclosed and dust proof and is suitably geared to develop the necessary power up to the capacity of the drill. The machine may be carried from point to point around the shop, its sphere of action being limited only by the length of the flexible wire connection. Its weight is 95 pounds and extreme height 30 inches over all.



Electrically-driven "Scotch" Drill.

COLD SAW CUTTING-OFF MACHINE.

A new cold saw cutting-off machine that has just been designed and built by the Espen-Lucas Machine Works, Philadelphia, Pa., is illustrated in the half-tone herewith. It has a capacity for cutting 4-inch round stock, and structural shapes up to 6-inch I-beams, at one cut. The saw has variable automatic feed, automatic safety stop, and swivel clamp on the platen for holding different shapes and sizes of material to be cut straight or at an angle. This clamp may, if desired, be entirely removed, allowing jig work to be placed on the table. The machine is driven by steel worm and phosphor bronze worm wheel running in an oil bath. The design of the machine is such as to occupy very little floor room but at the same time the materials of construction are so disposed as to give the unusual stiffness necessary for cutting the large sizes of stock for which the machine is built. Arrangement is made for carrying saw blades up to 14 inches in diameter.



Cold Saw Cutting-off Machine.

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OBITUARY.

James N. Skinner, late superintendent of the Skinner Chuck Co., New Britain, Conn., died at his home in that city November 8. Early in his career Mr. Skinner served in the regiment of the Connecticut Volunteers during the Civil War, and later entered the service of the Government at the Springfield Armory. After this he was employed by the Howe Sewing Machine Co., of Bridgeport, and from there went to the works of the E. Horton & Son Co., at Windsor Locks, where he remained for fourteen years. It was while with this concern that he took out several patents on chucks, and in 1887, when the Skinner Chuck Co. was organized, he was elected superintendent and director of that company, a position which he held until his death. Mr. Skinner was well known as the originator of several inventions and of many improvements in the line of manufacture to which he devoted his life.

* * *

DECEMBER MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The forty-eighth meeting of the American Society of Mechanical Engineers will take place December 1 to 4. At the opening session, December 1st, Mr. James M. Dodge, president of the society, will deliver the annual address, "The Money Value of Technical Training." The papers for the following sessions are as follows:

Wednesday morning, December 2, at 113 West 40th St.—"Is Anything the Matter with Piece Work?" by Frank Richards; "Modifying Systems of Management," H. L. Gantt; "Slide Rules for the Machine Shop as a Part of the Taylor System of Management," by C. G. Barth; "What are the New Machine Tools to be?" by John E. Sweet; "Suggestions for Shop Construction," by F. A. Scheffler.

Thursday morning, December 3, at Stevens Institute of Technology.—"The Pitot Tube," W. B. Gregory; "Method of Determining Rates and Prices for Electric Power," F. B. Perry; "Three and Four Wire Multiple Voltage Systems," Louis A. Gillet; "Test of a Compound Engine Using Superheated Steam," D. S. Jacobus; "The Pressure Temperature Curve of Sulphurous Anhydride (SO)," E. F. Miller; "Construction and Efficiency of a Fleming Four-valve Engine," Benj. T. Allen.

Friday morning, December 4, at the Society House, 12 West 31st St., New York.—"A Compact Gas Engine, Beam Type," C. H. Morgan; "Standard Unit of Refrigeration," J. C. Bertsch; "Series Distilling Apparatus of High Efficiency," W. F. M. Goss; "Air Motors and Air Hammers, Apparatus and Methods for Testing," Max H. Wickhorst; "Valve Motion of Duplex Air Compressor," S. H. Bunnell.

It has been decided to hold the spring meeting, 1904, at Chicago. This will enable members who intend to visit the Louisiana Purchase Exposition to make an easy journey to St. Louis, and will obviate the discomfort incident to a convention in a crowded exposition city.

* * *

TECHNICAL EDUCATION.

Louis Duncan in Engineering Magazine, November, p. 161.

The fault of our technical education in America is that it is too technical and that there is too much instruction. It seems to be the idea that the longer contact the student has with his lecturers or with his text books the more information he will obtain. It does not seem to be considered that information, as such, is not of great importance. It can be obtained easily and cheaply when occasion arises; and the end and aim of a technical education should be not to obtain information, but to apply it. We should not attempt to make mental storehouses of men, but mental factories.

Another thing is this: that to a large extent, the ability of a man to work out any specific problem depends on his being able to make a mental plot of the problem, and to keep it constantly before him. For instance, a railroad proposition for a city, presented to an engineer, involves an infinity of different considerations—the population of the different districts of the city, the character of the population, the growth, the franchises under which the road is to be built, the political complexion of the city government, the question as to whether the capitalists who are building the road intend to operate it or to sell it—these and a hundred other considerations must form part of the plan adopted. To take all these into account, to keep them constantly before one until the scheme works itself out, requires an imagination that has been developed and not suppressed. A large part of the work is done outside of any office—in street cars, at dinner—unconsciously to a certain extent.

I wish specially to emphasize this point. The amount of work done at desk or before a drawing-board is a very small proportion of the total work needed for a large engineering proposition. The successful engineers are those who can see the problem as plainly while they are walking on the street as they can see it on a blue-print.

I saw some time ago in one of the daily papers a discussion of the requisites for success in life, and some one, I think it was Mr. Cleveland, summed things up by giving as the three requisites—character, persistence, and intellect. The fact that intellect was placed third on the list surprised many people, but this is true. Suppose a brilliant man does a certain piece of work in a certain time; another man does the same work in twice the time; the first is usually considered has having about twice the intellect of the second, and by the ordinary definition of intellect, which emphasizes the time element, this is true. But any one with average brains can work out any reasonable proposition, provided he works at it long enough, and his ability, of which I have spoken—the ability to keep a proposition constantly in front of one, the quality of imagination—constitutes the difference between the finally effective man and the so-called brilliant thinker. Brilliancy is merely the time-factor of application. Newton said that his success was not due to the fact that he was smarter than other people, but to the fact that he thought more than other people.

In looking over the list of successful engineers (I am speaking now of electrical engineers, because I know very little of any other branch), we do not find that we can point to any one institution as having produced more successful engineers than any other in such a way as to make the difference marked. In fact, I am afraid that our largest and best equipped institutions do not show as fair a percentage of leading engineers as some of the smaller, poorly equipped colleges. I think this is due to two things; the first is that the larger institutions have presented courses including more instruction than can be given in smaller institutions, and I believe that at least half of this has done harm rather than good. The other cause is obvious, i. e., that in the smaller institutions the students are more directly in contact with the instructors, and that they do not have the facilities for work that the more ambitious colleges have; that is, when an experiment is to be tried, the ingenuity of the student, and not his patience, is exercised.

The power mechanism for the vertical traverse of cross-rails on planers and boring mills has generally been made to give the same speed whether going up or down. It is obvious that the power required when moving upward is much greater than when going down, but with the mechanism using the ordinary tumbler gears for reversing the direction of travel, it has not been easy to vary the ratio, consequently it has usually been made in a 1 to 1 ratio. If, however, a friction clutch is used for reversing the direction of vertical traverse, the ratio is easily made whatever good design would suggest. We believe the Cincinnati Planer Company was the first to do this regularly, their planers all being made with the ratio of upward to downward travel as 1 to 2. The King Machine Tool Company have applied the same idea on the new line of boring mills which they are bringing out. The plan of using friction clutches instead of tumbler gears has another advantage, and that is there is less racket, especially when spiral gears are used in the combination.

Commissioner Lindenthal of the New York Bridge Department announces that the new Williamsburg bridge (New York to Brooklyn) will be opened to pedestrians and teams about December 19. The approaches are rapidly nearing completion, and the bridge itself is finished save for minor details which will be ready by the time the approaches are done. It is not expected that street cars will run over it for some time as it has not yet been decided what company will be granted the privilege. The Brooklyn Rapid Transit and the Interborough companies are competing for it.

The great advance in the art of forming difficult metal shapes by heavy pressure is indicated by the organization of a company in Milwaukee, Wis. (the American Standard Steel Fitting Company), to make pressed steel pipe fittings from ordinary boiler-plate steel. These fittings will, it is said, be somewhat more expensive than cast iron, and about the same price as steel castings. Being seamless and non-porous such fittings should be superior to all castings, and, therefore, particularly acceptable in refrigerating plants because of the well-known difficulties of handling ammonia in extensive pipe systems without serious loss, due to defective fittings, etc.

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FRESH FROM THE PRESS.

The Mechanical Engineers' Pocketbook, by D. K. Clark. Published in America by the D. Van Nostrand Company, New York. 690 pages. Illustrated. Price, $3.00.

This is a new edition of Clark's well-known English handbook. Mr. Clark died previous to its complete revision and Mr. H. H. P. Powles, an English engineer, is responsible for the corrections, revision and additions made necessary in bringing out this edition. The book is handsomely bound in leather, with round corners, and is very convenient for use.

Engineering Preliminaries for an Interurban Electric Railway, by Ernest Gonzenbach. Published by the McGraw Publishing Company, New York. Illustrated. Price, $1.00.

As the title indicates, this book of 71 pages is a review of the engineering preliminaries that should be considered in the projection of an interurban electric railway, which are taken up under the captions: Estimated Income, General Requirements, Third Rail vs. Trolley, Location, Roadbed and Track, Rolling Stock, Electrical Car Equipment, Car Shops, Power Stations, Transmission Line, Distributing System, Third Rail, Accessories, Estimate, Operation, etc.

Fowler's Mechanical Engineers' Pocketbook for 1904, edited by William H. Fowler, published by the Scientific Publishing Company, Manchester, Eng., and for sale in this country by the Derry-Collard Company, New York. Price, 60 cents.

This book has been added to from year to year until now it contains 450 pages of closely printed matter and has a great deal of valuable information upon all branches of mechanical engineering.

The policy of revising this book each year, and adding to it, has made it possible to keep it in touch with recent practice, and much information is gathered within its pages that is not available in any other one place. The index is unusually complete.

Compressed Air, by William Charles Popplewell. Published by the Scientific Publishing Company, Manchester, Eng., and for sale in this country by the Derry-Collard Company, New York. 285 8vo pages. Illustrated. Price, $3.00.

This is a new book treating of the theory and practice of pneumatic power transmission. There are descriptions of several types of air compressors or motors, and of the numerous compressed air tools that have been placed on the market during the past few years. There is also a brief treatment of air transmission and the efficiency tests of compressors and transmission system. The book is almost entirely descriptive, but one chapter being devoted to compressed air calculations.

Airbrake Catechism, by Robert Blackall, Airbrake Instructor and Inspector with Westinghouse Airbrake Company. 304 12mo pages and 98 illustrations. Published by Norman W. Henley & Son, 132 Nassau Street, New York. Price, $2.00.

An extended review of this book, which may be said to be the standard catechism of the airbrake, is not necessary; it is too well known to require it, having passed through seventeen editions. The present edition, the eighteenth, has been revised and brought thoroughly up-to-date. It is a complete study of the airbrake and signal equipment, and we are told that it has been endorsed and is used by nearly every instructor and examiner on the railways of the United States. Two large Westinghouse airbrake educational charts, each 14 x 50 inches, printed in colors, accompany each book.

Electric Railway Economics, by W. C. Gotschall. 252 pages. Illustrated. Published by the McGraw Publishing Company, New York. Price, $2.00.

This book is based on a series of lectures delivered by the author at Lehigh University upon the economics and preliminary engineering of high-speed and heavy traction interurban electric railways. The great interest that has been aroused in high-speed electric railways by the recent tests abroad and the strong probabilities of very extensive work in this line in the near future here, make any authoritative literature on the subject of timely interest and most acceptable to engineers and others. The work not only takes up the engineering features of survey and construction, but also treats of the organization of the operating department and the economic considerations determining the magnitude and details of the proposed road. Several folded diagrams and cuts are presented. The appendices give the specifications for a moderate-sized interurban road and a bibliography referring to important articles on high-speed and heavy traction that have appeared in some of the various technical journals.

Home Mechanics for Amateurs, by the late George M. Hopkins, of the editorial staff of the Scientific American. Published by Munn & Co., New York. 370 pages. Illustrated. Price, $1.50.

This is a companion book to the "Experimental Science" by the same author, which has had a very large sale. As the title of the book indicates, it is for the amateur, not for the workman who understands practical methods or who has practical work to do. In this country the amateur is mainly the American boy. Amateur work in wood and metal is not so popular here as in England, but nevertheless this book, which seems to be practical, will probably appeal to many, both old and young, who like to make knicknacks and all sorts of devices for use about the house, but who have not the practical knowledge necessary to either invent them or to make them without instructions from outside. The chapters are seven in number, taking up woodwork, household ornaments, metal work, model engines and boilers, meteorological instruments, telescopes and microscopes and electricity. Mr. Hopkins, the author, died just previous to the completion of the work, but he had given the proofs their final revision, so that the book is completely the work of its author.

Engine Tests and Boiler Efficiencies, by J. Buchetti. Translated by Alexander Russell, an English authority, and published in this country, by Norman W. Henley & Son, 132 Nassau Street, New York. 256 8vo pages. Illustrated. Price, $3.00.

The first hundred pages of this book are devoted to an explanation of the indicator and indicator diagram, with descriptions of several kinds of instruments, some of which are not entirely familiar to American readers. After this follow chapters on testing gas and oil engines; the measurement of brake horse power; the use of a dynamo as a brake, and a very brief chapter on testing steam turbines. The book concludes with chapters on the properties of steam, evaporation, combustion, and an appendix containing notes, tables, etc. All the tables and calculations which in the original appeared in the metric or French units have been converted into English units, so that the book can easily be used by readers in this country. The subject is clearly treated and as it undoubtedly fairly represents continental practice, the volume should prove of considerable interest to consulting engineers who are engaged in testing according to methods which have become standard in the United States. From the fact, however, that continental practice differs somewhat from our own, the book would not be as well adapted to a student as one which followed the standard methods of this country.

Locomotive Breakdowns, Emergencies and Their Remedies, by George L. Fowler, M.E., 250 12mo pages and 96 illustrations. Published by Norman W. Henley & Son, 132 Nassau Street, New York. Price, $1.50.

This book treats, in catechism form, of the various accidents and breakdowns to which the steam locomotive is liable, and gives in each case a practical and simple method of handling same, so that a locomotive may proceed under its own steam or be safely towed in. It is a book containing many practical suggestions that should be of value to almost every locomotive engineer,, wrecking boss, roundhouse foreman, shop foreman and others desiring to make themselves proficient in the handling of locomotive repairs and emergencies. For instance the first chapter, treating of valve defects, tells how to locate and distinguish valve and piston steam leaks or "blows," as they are commonly known in railway parlance, and it alone should be worth the price of the book to those having to do with these sometimes obscure and puzzling defects. Besides the chapters treating of road repairs to valves, steam chests, cylinders, pistons, guides, crossheads, running gear, springs, frames, throttles, trucks, airpumps, injectors, lubricators, etc., a chapter is devoted to certain methods of shop repairs that are good; also one on aid to the injured. When it is considered that often a man's life is sacrificed simply because of the ignorance of his companions as to the proper treatment of a ruptured artery, it certainly seems worth while to instill some elementary surgical knowledge into the training of railway men.

Machine Design. Part I. Fastenings. By William Ledyard Cathcart, adjunct professor of mechanical engineering, Columbia University. 290 8vo pages. Illustrated. Published by D. Van Nostrand Company, 23 Murray Street, New York. Price, $3.00.

Several years ago we gave favorable notice of the work on machine design by Prof. Forrest R. Jones which was issued at that time, and said that it was of peculiar interest as being the first comprehensive treatise on the subject which covered machine design very thoroughly, being comparable in this respect to the English work by Unwin. This new book by Prof. Cathcart should also receive favorable notice and, although not a pioneer in its field, like the other treatise, is none the less interesting, since it apparently is the beginning of what will eventually be a more extended and perhaps complete, though we judge hardly a more workable, presentation than the volumes by Prof. Jones. The thoroughness with which Prof. Cathcart has gone into the matter is evident from the fact that this whole volume is devoted to this one subject of fastenings. The first chapter gives the most complete and satisfactory treatment with which we are acquainted, of shrinkage and pressure joints. The treatment is theoretical, supplemented by tables, several of which have been made up from similar tables appearing in Machinery. The chapter concludes with a treatment of shrinkage in gun construction. Following this come screw fastenings, riveted joints, keyed and pin joints. Throughout the work there are theoretical mathematical discussions and tabulated sizes, for convenient reference. The book abounds in tables, not only of dimensions, but of strength of materials, the properties of matter, etc. Considerable attention is given to U. S. Government specifications for screws, riveted joints, etc. To illustrate what is done in the way of theory may be mentioned the stresses in screws, torsion due to thread friction, stresses in nuts, efficiency of the screw. Altogether the volume is to be recommended as an advanced and practical reference work on such parts of machine design as its pages treat.

The Gas Engine, by F. R. Hutton, professor of mechanical engineering, Columbia University. 483 8vo pages. Illustrated. Published by John Wiley & Sons, New York. Price, $5.00.

The most widely-known books on the gas engine at the present time are the three English works by Donkin, Robinson, and Clerk. These consider the British types of gas engines, and while they go into the subject exhaustively, they are not of such character as to place the reader in touch with the wonderful gas engine development in this country in the past few years. Up to the time of the appearance of Prof. Hutton's volume there has been no comprehensive American treatise on the gas engine, such as have appeared being either of a popular nature or else dealing specifically with gas engine design. The present volume is intended to be a comprehensive American treatment, unsparing in its theoretical deductions, with due consideration of the application of theory to practice. The most exhaustive chapter, and one which will be appreciated by the investigator, although deeper than the average student would be anxious to go into—unless he were an accomplished mathematician—is one on the theoretical analysis of the gas engine. This chapter takes up the different gas engine cycles more completely than any previous work. The volume presents what is latest in connection with the blast furnace and producer gas apparatus. The first three chapters are introductory, reviewing the physical properties of hydrocarbon for power purposes, touching upon the various gases available, for use in an internal combustion engine. Following this is a discussion of a heat engine cycle; chapters on gas, gasoline, kerosene, and alcohol engines; carbureters; methods of ignition; governing, etc. There is a chapter on experiments with explosive mixtures, one on the performance of gas engines by tests, and one on the manipulation of gas engines which considers the ills that such machines are heir to. While many of the chapters are easily read and free from mathematics, the work on the whole is an advanced treatise and one to interest the mechanical engineer or designer.

The following books have been received:

A Textbook of Electrical Machinery, Vol. I. Electric Magnetism and Electrostatic Circuits, by Profs. Ryan and Norris, of Cornell University, and Mr. George L. Hoxie. Published by John Wiley & Sons, New York. Price, $2.50.

This is a theoretical textbook for students' use.

The Arithmetic of Electricity, by T. O'Connor Sloane. Published by Norman W. Henley & Son, 132 Nassau Street, New York. 160 12mo pages. Illustrated. Price, $1.00.

This is the sixteenth edition, revised and enlarged, of this popular work on electricity.

Electric Toy-making for Amateurs, by T. O'Connor Sloane. 185 12mo pages. Illustrated. Price $1.00.

This is the fifteenth edition, revised, to which several chapters have been added containing descriptions of a number of new and interesting devices.

Manual of Screw Cutting, by William Simpson, Lock Box 8, Wollaston, Mass.

This little handbook deals with screw cutting and change gears, has several useful tables, and gives directions for making a number of calculations, such as sizes of pulleys, etc. It contains 73 pages. This is the sixth edition.

Roof Framing Made Easy, by Owen B. McGinnis. Published by the Industrial Publication Company, New York. Second edition. Price, $1.00.

St. Nicholas, for December, is a real Christmas-stocking number, brim full of holiday stories and pictures, verse and fun. "An Interrupted Auction," by Carolyn Wells; "The Road to Fairyland," by Ernest Thompson Seton; "St. Saturday," by Henry Johnstone, with a page picture of the old Saint; "Happy Days," by Sarah S. Stilwell, and there are other shorter jingles pleasant to read between the stories.

Temple Bailey's "The Bachelor's Doll," is a delightful tale. In "The Three Caskets" George M. R. Twose retells for young readers the story of Portia and her three caskets. Ralph D. Paine gives an account of "A Chinese Army That Cheered for Yale"; Anna Porter Rex tells of "President Washington's Turkey Dinner"; Cyrus Townsend Brady, a humorous account of "The Baby's Adventurous Day—and Mine"; the "Adventures of a Tin Soldier" are recounted by Charles Raymond Macauley; Julian King Colford writes interestingly of "The Signs of Old London." New chapters of B. L. Farjeon's "A Comedy in Wax" carry the characters through many exciting adventures, etc.

The *Century* for December is particularly attractive and entertaining. There is an artistic cover and quite a number of pictures in color throughout the magazine. Of course a number of articles have the Christmas flavor, such, for instance, as "A Christmas Rescue," by Alfred Bigelow Paine, illustrated with pictures by Miss Cory; "How Santy Claws Treated Pop Baker," by the late Elizabeth Cherry Waltz; "Christmas Mangers," by Emma E. Porter, and "A Christmas Dilemma." Alice Katherine Fallows in "Temptations to be Good" sets forth certain good influences on the New York East Side boy, while Lucy Derby Fuller contributes a reminiscent paper on "Phillips Brooks and the Girls' Club." Another instalment of the new Thackeray find, consisting of his letters to the Baxter family of New York and some of his drawings, show him in intimate and lovable moods. There is a group of negro songs by Joel Chandler Harris, Paul Laurence Dunbar and others, with pictures by A. B. Frost. The range of fiction is further enlarged by a story by Roy Rolfe Gilson, "The Poet of a Day," illustrated; a humorous story by Maurice Francis Egan; a character sketch by J. J. Bell, a story of peasant life entitled "The Promise," by Maarten Maartens, the Dutch novelist, etc. Ernest Thompson Seton has another group of sketches of nature, entitled "Fable and Woodmyth." There is a curious paper by André Saglio on "The Bigoudines" of Brittany, with illustrations; a sketch entitled "Chrysanthemums," by Maurice Maeterlinck. Dr. James M. Buckley writes of "Fanaticism in the United States," in which there is additional reference to "Elijah the Restorer." Franklin Clarkin describes "The Daily Walk of the Walking Delegate."

NEW TRADE LITERATURE.

The Buffalo Steam Pump Company, Buffalo, N. Y. Leaflet describing the Buffalo Underwriter fire pump.

E. G. Smith, Columbia, Pa. Circular, just published, of the calipers and levels manufactured, will be sent to any one interested.

The American Diesel Engine Company, 11 Broadway, New York. Pamphlet describing and illustrating the Diesel engine, American type. This engine is here treated very fully and illustrations show its pump, motor, admission valve, etc.

The Cincinnati Punch & Shear Company, Cincinnati, O. Catalogue No. 9, illustrating and describing the full line of power punching and shearing machinery, rolls, etc., designed and built by this company.

The Detroit Pump Company, Detroit, Mich. Catalogue of the Blackmer rotary pump. Illustrations show its interior construction, also the No. 4 and No. 6 belt pump, a No. 4 special and a No. 4 hand pump.

Warren Webster & Co., Camden, N. J. Part 5 of general catalogue, which describes and illustrates the Webster motor valve for use in connection with the Webster system of low-pressure steam circulation for heating.

H. B. Underwood & Co., Philadelphia, Pa. Illustrated catalogue, 1903, of portable tools for railway repair shops. Boring bars, for various purposes, crank-pin turning machines, portable milling machine, portable rotary planing machine, valve seat rotary planing machine, etc., are here described.

The Divine Brothers Company, Utica, N. Y. Circular descriptive of polishing wheels, samples of which are shown. These include sheep skin wheels, bull neck solid-leather wheels, wool felt, canvas, sheepskin, compress felt and cloth wheels. The circular describes each style.

The E. F. Reece Company, Greenfield, Mass. Catalogue No. 5 of screw plates, taps, dies, etc. The different sizes and varieties of these tools are given, together with price; and the manufacturers state that for taps and dies of special form, size or pitch not listed in this catalogue prices will be quoted on application.

The American Tool Works Company, Cincinnati, O. Illustrated booklet describing several types of improved metal-working machinery designed and built by this company. These include engine lathes, a high-speed lathe, crank shapers, standard metal planers, drill presses, radial drills and a 37-inch boring and turning mill.

The Crocker-Wheeler Company, Ampere, N. J. Bulletin No. 39 describing the equipment of the Orange, N. J., Brewery with the Crocker-Wheeler system of electric motor drive. Different views show: The electric generating units, the power plant where the refrigerating machines and electric generators are installed; the cooker, driven by motor, and a pump and a keg-washing machine, both motor driven.

The Peerless Rubber Company, 16 Warren Street, New York. Illustrated catalogue No. 60, October, 1903, of rubber goods for mechanical purposes. This book contains 150 pages and lists packings of all kinds for various purposes, gaskets, a large line of rubber belting, rubber hose, rubber tubing, rubber valves—in fact everything in this line—in a very complete manner. All the varieties of goods are illustrated and briefly described.

The Prentice Bros. Company, Worcester, Mass. Booklet entitled "Radial Efficiency," which describes the radial drilling machines of the company's make. They state incidentally that they have built, up to July 1, 1903, 2,064 radial drills, and this booklet calls attention to the novel and important features of their new line of radials, which are described quite fully and whose parts are illustrated by half-tone cuts.

The Woolley Foundry & Machine Works, Anderson, Ind. Illustrated catalogue, standard size, of the "Burger" gas engines. The company claim for these engines simplicity of design and construction and small number of working parts; durability and freedom from repairs; ease in starting and operating, and economy in consumption of fuel. The Burger type of engine and its various parts are here shown.

The National Automatic Tool Company, Dayton, O. Illustrated catalogue of automatic drilling and reaming machinery. This contains handsome illustrations of "Nutting's" automatic universal multiple spindle drill press, described some time back in the columns of our paper; of the Nutting automatic multiple drilling machine for sewing machine arms, and of the Nutting rotary platen automatic multiple drill which is described elsewhere in this issue.

The B. F. Barnes Company, Rockford, Ill. Illustrated catalogue of drills, lathes and a water tool grinder. The drills range from the 12-inch to the 31-inch size, and are built with from two to six spindles, in many varieties. One illustration shows a battery of six 20-inch drills, with round base and power feed, which is furnished with various combinations of feed required and arranged for all sizes of drills. The lathes include 9 and 11-inch screw cutting lathes.

The Abendroth & Root Manufacturing Co., Newburg and New York. Advertising literature of the products of this company. A catalogue of 64 pages illustrates and describes their "Root" water-tube boilers, and half-tone views show the method of replacing a tube in these boilers, the operation of removing and replacing requiring but 48 minutes. A large number of cuts show prominent plants and public buildings equipped with "Root" boilers. A price list, June, 1903, of the "Root" spiral riveted pipe and a number of other pamphlets dealing with the "Root" boilers and pipe, have also been received.

The Buffalo Forge Company, Buffalo, N. Y. Sectional catalogues of Buffalo mechanical forced draft and of steel pressure blowers, just issued. These are attractive pamphlets, the first describing the works of the company and the fan for forced draft which they manufacture. A number of interesting views illustrate the many varieties of fans, some being shown applied to boilers, engines, pumps, etc. The booklet on blowers illustrates the various types, and tables of their dimensions and the prices are given. The Buffalo automatic cut-off engine, of their manufacture, is also illustrated.

The Joseph Dixon Crucible Company, Jersey City, N. J. "Graphite Suggestions," an attractive booklet treating, as the title indicates, of the company's product—graphite. This is made for a great variety of purposes, as follows: For the extensive line of pencils, about one thousand different kinds, which the company make; for use in the foundry; for lubricating purposes; for belt dressing; as a pipe joint compound; for stove polish, etc. The Dixon Company here state that they issue special circulars or pamphlets of their many and various productions, in which each is treated individually and fully.

The McCullough-Dalzell Crucible Company, Pittsburg, Pa. Folder calling attention to the crucibles and plumbago products of this company. This concern have been making crucibles exclusively for thirty years and have a very extended trade among the steel industries. They state that their crucibles run uniform, that their life under like conditions will last through the greatest number of heats, etc., and that the material used in their manufacture is the best procurable. They also inform us that they are one of the four largest importers of plumbago in this country and being able to pick out their stock always procure the best material available.

The American Blower Company, Detroit, Mich. Three illustrated catalogues of the company's products, as follows: Illustrated sectional catalogue, No. 118, second edition, treating of the "A B C" system of mechanical draft, forced and induced by the use of blowers and fans, and several applications of these fans and blowers to boilers in various plants are shown; catalogue No. 145 (second edition) dealing with the fan system of heating and ventilation as applied to manufacturing establishments; catalogue No. 155 illustrating and describing the "A B C" steel plate fans. All three catalogues are handsomely gotten up.

The Hess Machine Company, 1002 Pennsylvania Building, Philadelphia, Pa. Illustrated catalogue, standard size, of milling machines and milling cutters. The company's 30, 36 and 42-inch machines for heavy work are listed here and they state they are prepared to widen out these machines to take in wider work, and they will build to order larger machines of proportionately greater power. Their specialty is heavy milling, fast milling and combined heavy and fast milling. The machines are furnished with electric drive when desired. This type of milling machine was described in Machinery in the September, 1903, issue.

The Ingersoll-Sergeant Drill Company, 26 Cortlandt Street, New York. Form No. 4—an advance copy of the new pamphlet which is being prepared for publication by the company, treating of the air hammers, drills, couplings, etc., manufactured. The Haeseler hammers, which were illustrated in Machinery, July, 1903, issue, are here described and illustrated in detail. The chipping hammers are made in five standard sizes; the riveting hammers in three sizes. The duplex pneumatic "holder-on," for use when hand-riveting, a portable oil rivet forge, the Haeseler No. 3 piston drill, a radial drilling frame for use with No. 3 drill, a rotary breast drill, etc., are also shown.

MANUFACTURERS' NOTES.

The Walworth Manufacturing Company are building a new brass foundry adjoining their works in South Boston, Mass., which will be 54 x 260 feet, six stories high.

The National Steel Foundry Company, New Haven, Conn., announce the establishment of an acid open-hearth steel casting plant, the first pouring to occur about December 1, 1903.

The Steel Set Diamond Company, New York City, manufacturers of emery wheel dressers, wire dies, etc., have removed from 275 Water Street to 36 Gold Street, New York.

The Lunkenheimer Company, Cincinnati, O., advise us that they have opened a branch office in Paris, France, at 24 Boulevard Voltaire, where they will carry a complete stock of their goods.

Frank Mossberg Company, Attleboro, Mass., manufacturers of metal stampings and metal machinery, have sent us a sample of their work in the shape of a handsome nickeled paper knife for opening letters, etc.

The Crocker-Wheeler Company, Ampere, N. J., inform us that they have established headquarters for the Southern representative of their Washington office, Mr. S. M. Conant, at 425 Empire Building, Atlanta, Ga.

The Pedrick & Ayer Company, Plainfield, N. J., announce that Robert O. Cumback, for several years with the C. R. R. of N. J., and later at the Elizabethport shops on special work, has accepted the position of superintendent of their new plant at Plainfield.

The L. S. Starrett Company, Athol, Mass., manufacturers of fine mechanical tools, have purchased the fine tool business of the J. Stevens Arms & Tool Company, of Chicopee Falls, Mass., including the entire stock of tools made up and in process, special tools and fixtures for manufacturing, patents and good will.

The American Tap & Die Company held a meeting of the directors October 21, at which Mr. Edward Wilbur tendered his resignation and J. Henry Nichols was elected president. It is the intention of the company to place its line of dies on the market January 1, 1904. At present they are making a full line of taps.

The Moore Drop Forging Company, Springfield, Mass., have recently increased their capital stock from $30,000 to $40,000. Mr. A. L. Moore was elected president and manager and Mr. A. H. Chapin, treasurer. The company's new plant is at Brightwood, Mass. It consists of three buildings: A drop shop, 50 x 74 feet; a press room 20 x 40 feet; and a machine shop, 45 x 64 feet.

The Savage & Love Company, 710 South Main Street, Rockford, Ill., manufacturers of engines, boilers, shafting, hangers and pulleys, are getting out a new catalogue which they state will soon be issued and which is to be very comprehensive. They also announce that they have taken over the selling end of the business of the National Engine Company. The Savage & Love Company also build woodworking machinery.

The Ingersoll-Sergeant Drill Co., Cortlandt Street, New York, manufacturers of air and gas compressors, rock drills, etc., announce that while awaiting the completion of their new compressor catalogue, they have issued a temporary reprint, No. 33B, designed to supply their needs until the new one is ready. Besides the matter contained in their former catalogues, it presents some new illustrations, and the tables have been revised and brought up to date.

The Standard Roller Bearing Company, Philadelphia, Pa., who recently purchased the ball business of the Grant Tool Company, inform us they have secured as sales manager of the ball business of their company Mr. T. J. Heller, formerly New York agent for the steel ball department of the Federal Manufacturing Company. Mr. Heller will make his headquarters care of the Standard Roller Bearing Company, 48th and Girard Avenue, Philadelphia, Pa.

The Carborundum Company, Niagara Falls, N. Y., are again enlarging their plant, having made a contract for 2,000 additional electrical horse power, which will be turned into the works this month, giving the plant a capacity of 10,000,000 pounds of carborundum a year. A new factory site has been secured on which is being erected a new mixing and furnace building, 146 x 134 feet, capable of being extended in two directions.

The American School of Correspondence, Armour Institute, Chicago, Ill., announce that Dr. Wm. A. Colledge, F.R.G.S., well-known as lecturer in English at the University of Chicago, has been appointed Dean of the American School of Correspondence at Armour Institute. Dr. Colledge is ably fitted for this position. He was educated at Glasgow and London and has spent many years in travel. By reason of his large acquaintance with unfrequented parts of the earth he was made a Fellow of the Royal Geographical Society. The office of Dean is a new departure for correspondence schools and marks the approach of these schools to the dignity of resident educational institutions.

The Standard Roller Bearing Co., Philadelphia, Pa., have purchased the entire ball business of the Grant Tool Co., Franklin, Pa. (formerly of Cleveland, Ohio), and are prepared to fill all orders for the celebrated Grant ball, formerly made by the Grant Ball Co., of Cleveland, Ohio. To supply the demand at once for balls, the business will be run for a short time in Franklin, so that orders can be filled without delay, but it will eventually be moved to Philadelphia and consolidated with the Standard Roller Bearing Company's plant in that city. All orders should be sent to the Standard Roller Bearing Co., Philadelphia, Pa. R. H. Grant, formerly manager of the Grant Ball Co., will have charge of the ball making plant in Philadelphia, and a number of the former employees of the Grant Company will remove from Franklin to Philadelphia, and enter the employ of the Standard Roller Bearing Co.

MACHINERY.

January, 1904.

THE NEW HAMILTON-CORLISS ENGINE WORKS.

THE shops of the Hooven, Owens & Rentschler Co., Hamilton, O., builders of the Hamilton-Corliss engines, have been rebuilt and greatly enlarged the past two years, and the new machine equipment is now practically completed. The scheme of arrangement of buildings, power plant, tracks, machines, etc., is that of Colonel J. C. Hooven, president of the company, and the details were worked out by the architect, Mr. George Barkman, of Hamilton. The buildings are most substantially constructed of steel frames with brick walls. The roofs are high and the lighting exceptionally good. The machine-tool equipment is in many instances of a special character, and is designed for handling both horizontal and vertical Corliss engines up to the heaviest units, say 5,000 or 6,000 horse power. The large tools are independently driven by electric motors, and electrical distribution of power is used throughout. In fact the plant is up-to-date, and is perhaps one of the best equipped plants in this country for building heavy Corliss steam engines.

The layout of the plant is seen in the plan, Figs. 5 and 6. The machine, erecting and blacksmith shops lie on the south side of Heaton street, and the foundry, pattern shop, pattern storage and power plant are on the north side. A large tunnel beneath the street connects the machine shop and power plant. In this tunnel the electric cables, steam pipes, water pipes and other connections are laid. The motive power in the power house consists of a 500 kilowatt Hamilton-Corliss cross-compound condensing engine, exhausting into a Baragwanath barometric condenser, and direct-connected to a "Wood system" generator built at Fort Wayne, Ind. For lighting a 150-kilowatt generator, belted to an 18 x 36-inch engine, is provided. For view of engine room see Fig. 18. The engine house is a handsome two-story building of pressed brick, and may be seen at the right in Fig. 19.

The tracks of the Panhandle Route (P. C. C. & St. L. branch of the Pennsylvania Railroad) are immediately adjacent to the shop buildings on the east, and the Cincinnati, Hamilton & Dayton Railroad runs along the west boundary. A switch from the latter curves through the side of the erecting shop, passes through the machine shop and back of the blacksmith shop, where it intersects that from the Panhandle Route. An industrial railway connects the machine shop with the foundry, foundry yard, etc., but transportation within the shops is mainly effected by the electric traveling cranes, with which the plant is exceptionally well equipped, there being eight in machine shop and erecting shops alone. The foundry has two, each of thirty tons capacity, besides which there is one of thirty tons capacity in the flask yard. For handling heavy patterns in the pattern shop a small traveling crane is provided there.

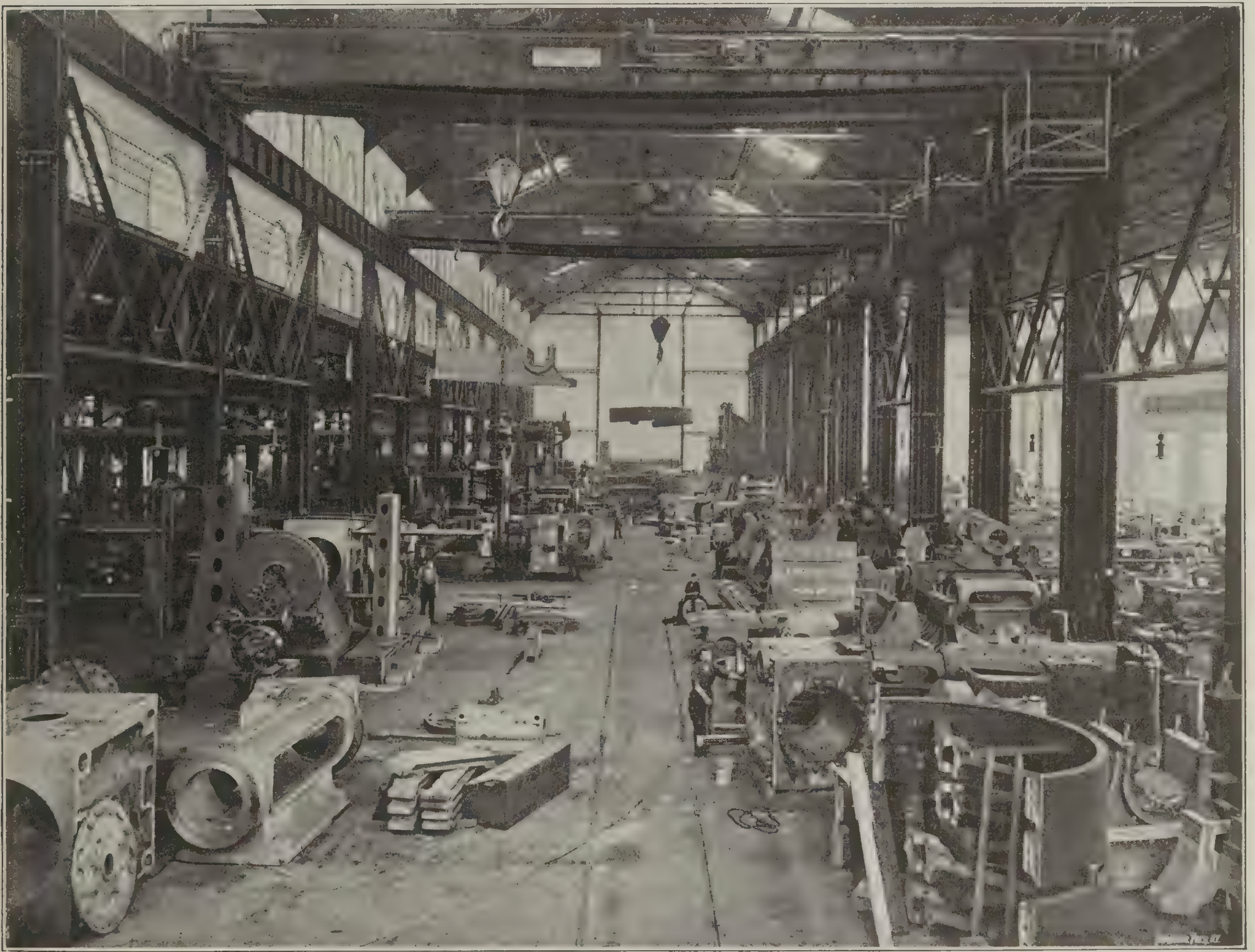


Fig. 1. Heavy Machinery Bay of new Hooven, Owens & Rentschler Engine Works, looking South, served by two Four-motor Fifty-ton Cranes of 73 feet 6 inches Span. Length of Bay, 370 feet.

The length of the foundry is 406 feet, and the width of the main part, in even figures, is 74 feet. A lean-to is built on the west side, as is the usual practice, for the cupolas and core ovens. The lean-to is continued, however, from the cupola room to the end of the structure, a distance of about 233 feet.

The width of the foundry with the lean-to is 113 feet. The foundry floors are composed of clay and molding sand, except in the charging and cupola rooms, where the floor is made of one-inch steel plates laid upon steel I-beams. The roof over the cupolas is fireproof, being built of steel rafters with porous book tile between and covered with sea-green slate laid in a bed of hot asphalt. This roof is especially recommended for cupola rooms, not only because of its fireproof qualities, but because the fumes and gases do not deteriorate it. Three cupolas of 67, 81 and 90 inches diameter, give ample melting capacity for the largest castings. Three wheel casting pits are provided in the north end of the molding floor. The wall of each pit is a cast-iron ring about 5 feet high, 3 inches thick and 23 feet internal diameter. As already stated, the foundry has two electric traveling cranes of thirty tons capacity each. The span is 69 feet 9 inches. A cross section of the foundry and lean-to appears in Fig. 9. The crane in the foundry yard for handling flasks is a lattice girder crane of thirty tons capacity, and is of the same length of span as those in the foundry. A view of this crane and the flask yard appears in Fig. 26, and view of the foundry lean-to, looking towards the machine shop, in Fig. 20.

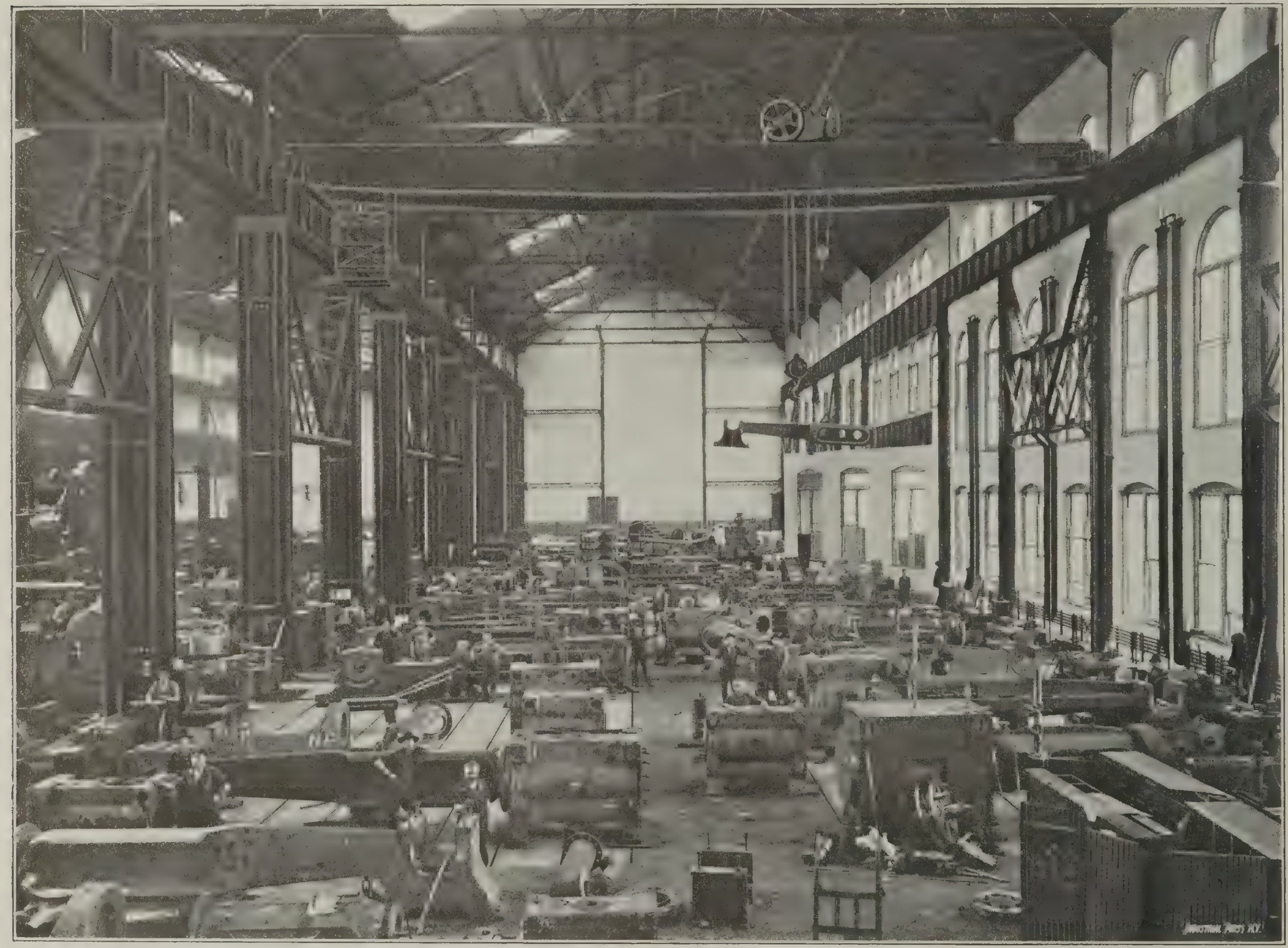


Fig. 2. Erecting Bay, 320 feet long. Has two Iron-concrete Erecting Floors, each 27 feet wide and 102 feet long; one Four-motor Thirty-ton Traveling Crane. Entrance for Railroad Switch shown by "jog" in Wall.

The machine shop extends along Heaton street 316 feet. The rebuilt part of the machine shop was part of the old foundry. This portion runs parallel with Heaton street and consists of two bays, each provided with traveling cranes. Views of these bays are shown in Figs. 4 and 24. The main erecting and machinery bays, four in number, 370 feet long and 230 feet wide, are at right angles to the street, as may be seen from an inspection of the plan, Fig. 6. A cross section of these bays is shown in Fig. 8, and half-tone views in Figs. 1, 2, 3, 21 and 22. The rectangular space included in the angle made by the east bay (running north and south) and the south bay (running east and west) is used as a fitting department for such engine parts as cam hooks, dash-pots, governors, etc. Beyond this department, toward the blacksmith shop is an old five-story building used for light machinery and storage. The screw machine department is on the ground floor, and the appreciation of the Jones & Lamson machines is shown by the fact that seven machines are in use, three of which are 2 x 36 inches capacity.

The most impressive parts of the plant are the high sections indicated in the cross section, Fig. 8, and of which half-tone views appear in Figs. 1, 2 and 3. The steel columns supporting the roof, are very heavy and are spaced 29 feet apart. All the weight of the roof throughout the plant, including the shafting, is supported by the columns, the brickwork acting only as a filling between the outside columns. The height of the roof trusses from the floor is 57 feet, and the tops of the crane runways are 45 feet above the floor. All the foundations are made of concrete, as actual tests had satisfied the company that concrete formed a more stable foundation than stone; besides its use hastened the work and cheapened the cost. The foundations of the floors are also of concrete, 8 inches thick. Upon this 4 x 6-feet cedar sleepers are laid, 2 feet apart center to center. The sleepers are coated on all sides with hot asphalt, and the space between them is filled up to the level of the top with fine concrete. Upon the sleepers the flooring is laid, which consists of 3-inch plank covered with a finished floor of 1¼-inch tongued and grooved edge-grained yellow pine. The sleepers are somewhat wider at the bottom than at the top, so they cannot lift, being dove-tailed, as it were, into the concrete.

The erecting floor space is 102 feet long and in two parallel sections each 27 feet wide. These are built of concrete, in which are embedded cast-iron rails each made with longitudinal T-slots. These rails are 6 inches deep and are made in 6-foot lengths, each of which is held down with six bolts. A bed of concrete 12 inches deep was rammed up to within one inch of the bottoms of the cast-iron rails, which were leveled and held in place by temporary supports. Liquid cement was then floated over the concrete up to the under side

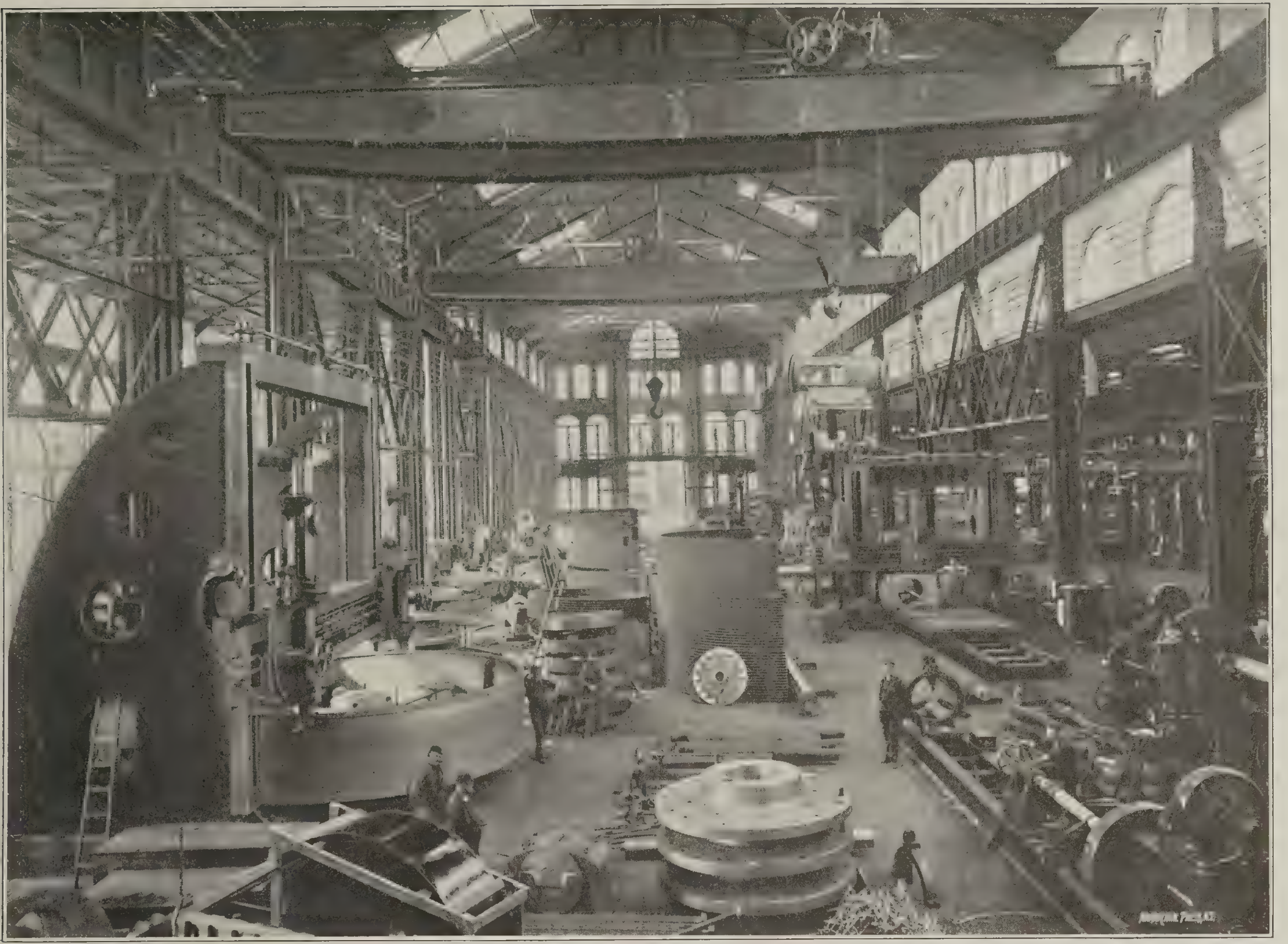


Fig. 3. Heavy Machinery Bay, looking North.

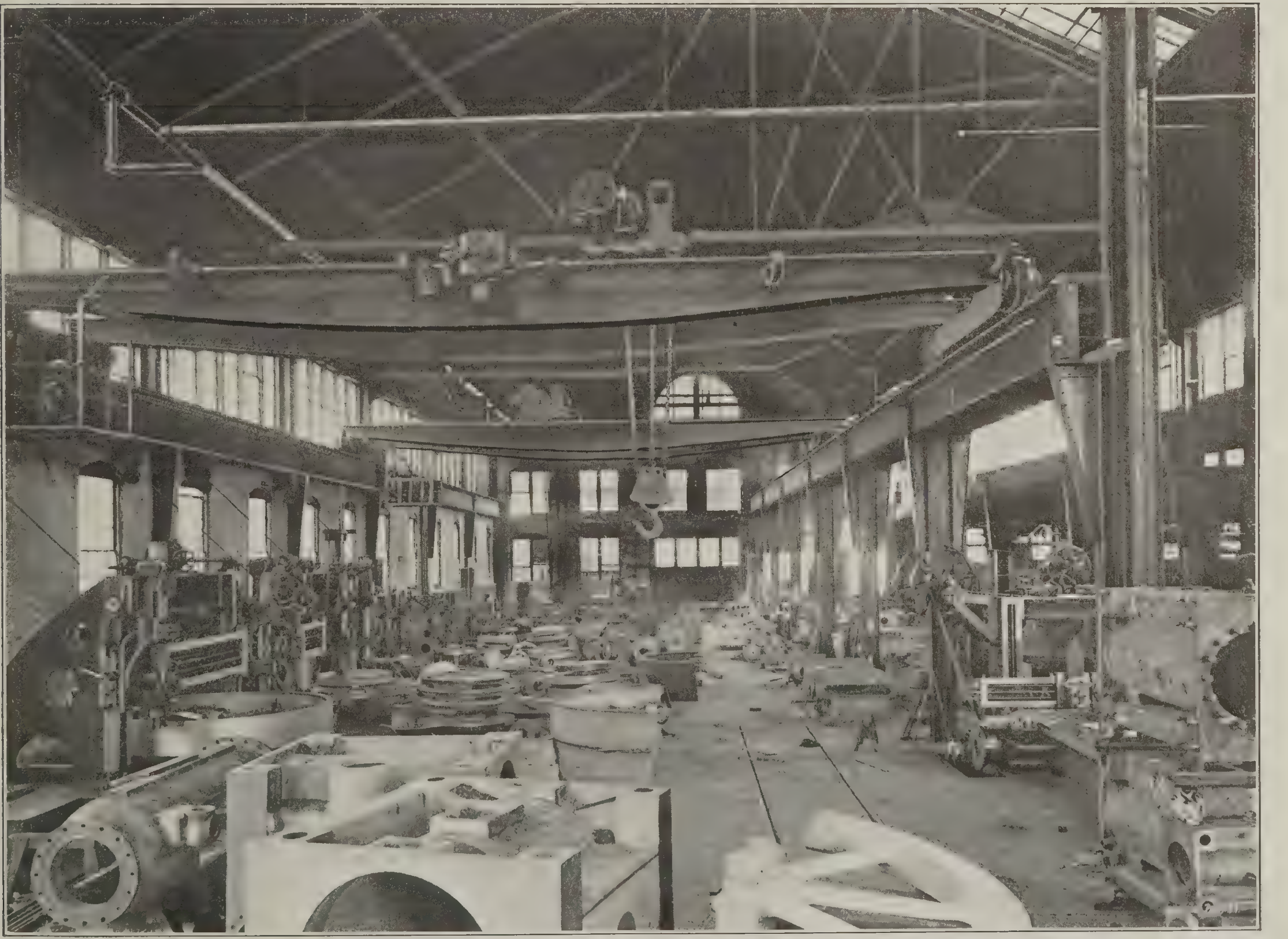


Fig. 4. Machinery Bay parallel to and next to Heaton Street, served by two Twenty-ton Traveling Cranes of 47 feet Span.

of the rails, thus giving them a perfectly even bearing under all parts of their bases, which are about 12 inches wide. The spaces between the rail were then filled in with rammed concrete up to within one inch of the top, and the intervening space was floated level full with liquid cement. The rails are laid about 3 feet apart center to center, and the T--slots may be plainly distinguished in the view of the erecting floor, Fig. 2.

The traveling crane over the erecting floor is of 30 tons capacity. It has four motors, the main hoist being driven by a motor of 30 horse power. The power of the other motors and of those of the two 50-ton cranes in the next bay may be read from the cut, Fig. 6. Save tools of a portable nature, there will be only one machine tool in the erecting section or bay. This is a 40 x 12-foot pit lathe, located at the south end. This machine had not yet been erected at the time the photograph was taken. It is a home-made tool and is now in process of construction. At the opposite end of the erecting floor is the office, which is four stories high and has a cellar. The stairways leading to the second and third floors are indicated in Fig. 8, and are on the shop side of the partition wall.

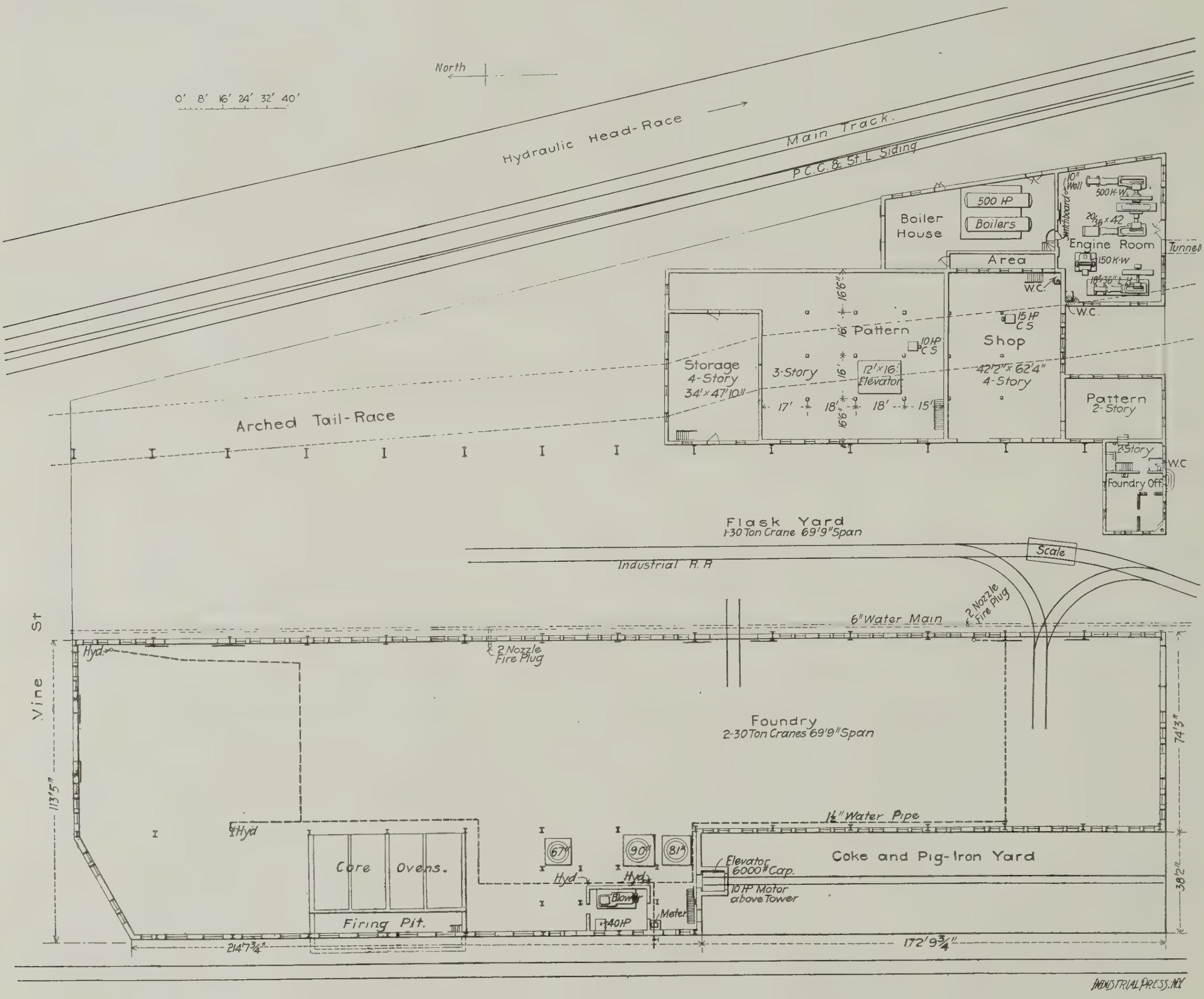


Fig. 5. Plan of Hooven, Owens & Rentschler Works, showing Foundry, Pattern Shop, Power Plant, etc. (See next page.)

The heaviest machine tools are in the next bay, which is served by the two 50-ton cranes. The heavy planer shown individually in Fig. 13 was built by the Niles Tool Works, as were most of the other heavy machines. It is a 12 x 12 x 30-foot machine, with four heads, and is driven by a 40-horsepower constant speed motor. Fig. 14 shows a view of a heavy 20-foot boring and turning mill from the rear. This machine has an auxiliary post or housing, carrying the tools for turning the rims of fly-wheels. It is driven by a 20-horsepower variable-speed motor, and has a 7½ constant-speed motor for rail elevation. The cylinder borer appearing in Fig. 15 handles Corliss cylinders up to 72 inches diameter, and bores the ports simultaneously with the machining of the main bore. The main bar is driven through worm gearing by a 12-horsepower variable-speed motor. The two port boring bars are independently driven by a 7½-horsepower variable-speed motor. Another interesting heavy tool is the bed-facing machine seen in Fig. 16. This machine has two boring bars mounted at right angles. One bar bores the main shaft bearing, while the other bores the guides and faces the end of the frame for the cylinder fit. Large and small bars with bushings fitting the machine so that they may be readily interchanged are provided, so that large and small frames may be handled on the same machine. The shaft bearing boring bar is driven by a 7½-horsepower variable speed motor, and the guide boring and facing bar is driven by a 12-horsepower variable-speed motor.

The Bullock four-wire multiple voltage system is used for the variable-speed motors. A balancing set consisting of three machines of 17½ kilowatts each, mounted on one base, is located centrally in the shop near the tool room. The power wires are all carried beneath the floor, and connection boxes are placed at frequent intervals. The only overhead wiring is that necessary for the electric lights. Near the balancing set is a 45-horsepower constant-speed motor, belted to the line shaft in that bay. In this section all the tools are belt-driven from the line shaft. A view of it is shown in Fig. 21.

This bay, of course, is not served by traveling cranes, because of the presence of the lineshaft, but primarily because of the low roof, this section being a lean-to, although the next bay is covered with an ordinary ridge roof. In the next bay there are two 20-ton traveling cranes of 34 feet 3½ inches span, and the tools are independently motor-driven. The power of the individual motors is, in most cases, given on

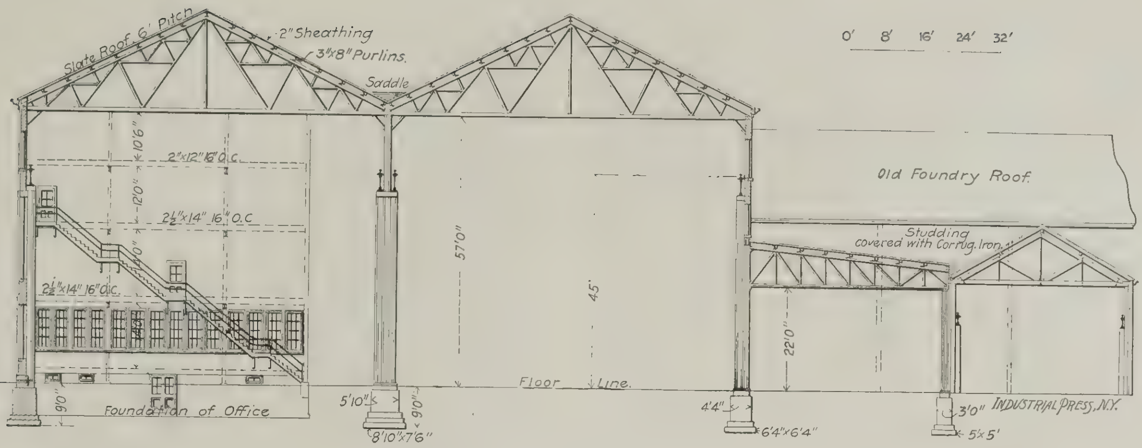


Fig. 8. Cross-section of Erecting and Heavy Machinery Bays; also of Lean-to and Ridge-roof Section.

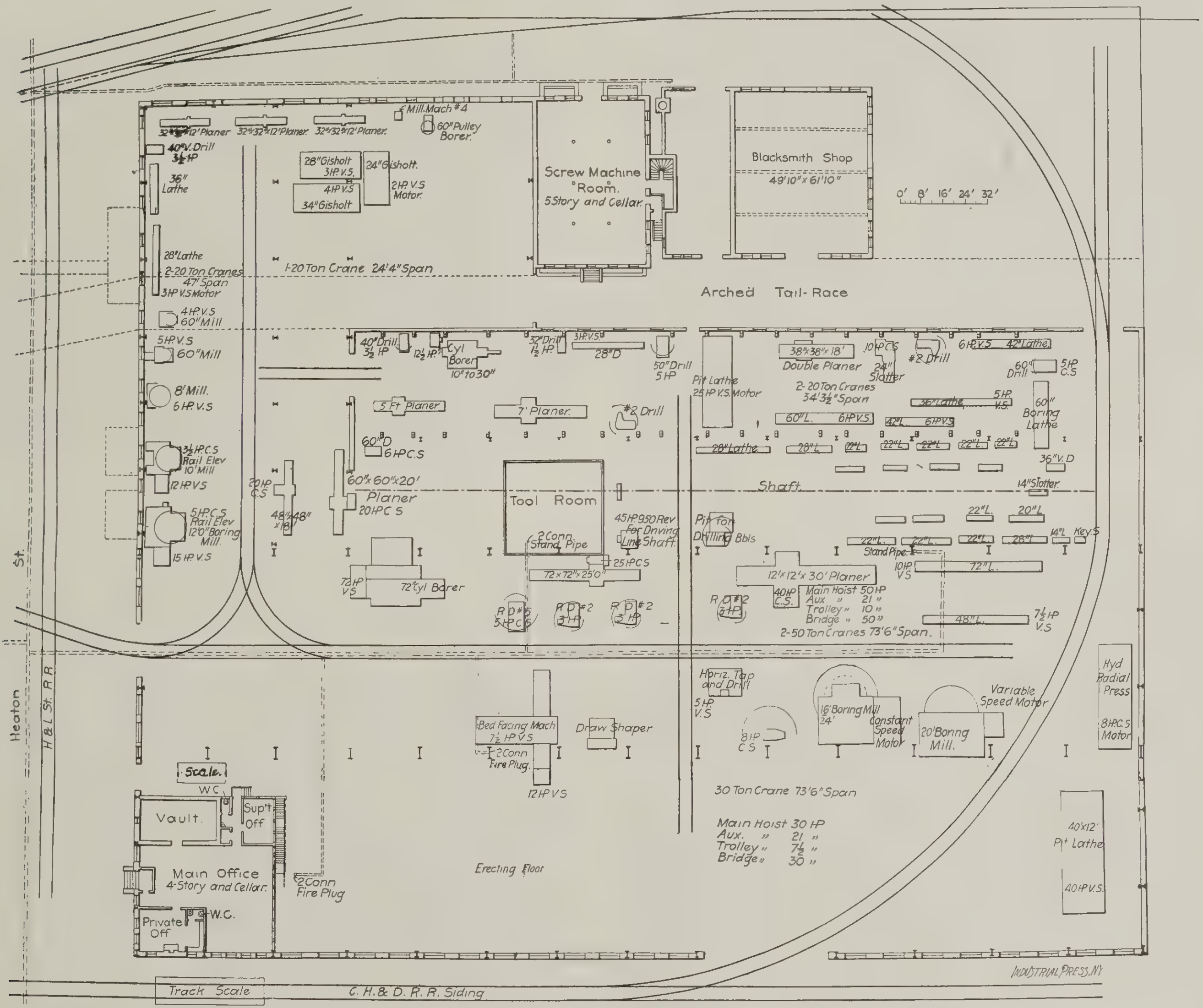


Fig. 6. Plan of Works showing Machine and Erecting Shops and Blacksmith Shop.

the drawing, Fig. 6. One of the interesting tools in this section is the Niles double connecting-rod planer, with which both ends of connecting-rods may be planed simultaneously; it is shown in Fig. 17.

The boring mill seen in Fig. 11 is one of a row of mills located along the Heaton street wall, shown in the general

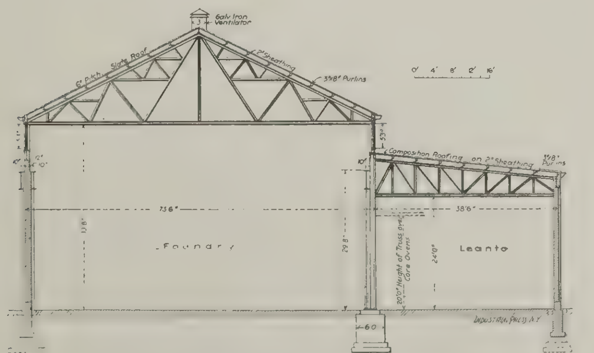


Fig. 9. Cross-section of Foundry.

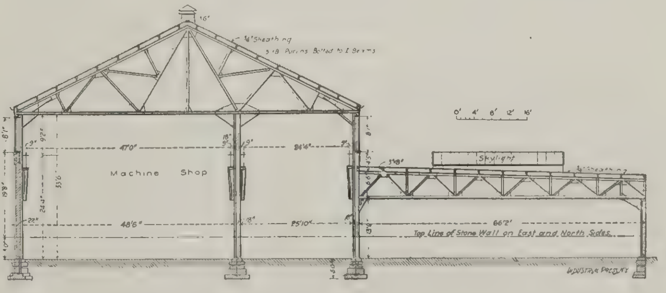


Fig. 10. Cross-section of Machine Shop Bays parallel to Heaton Street also of Fitting Department.

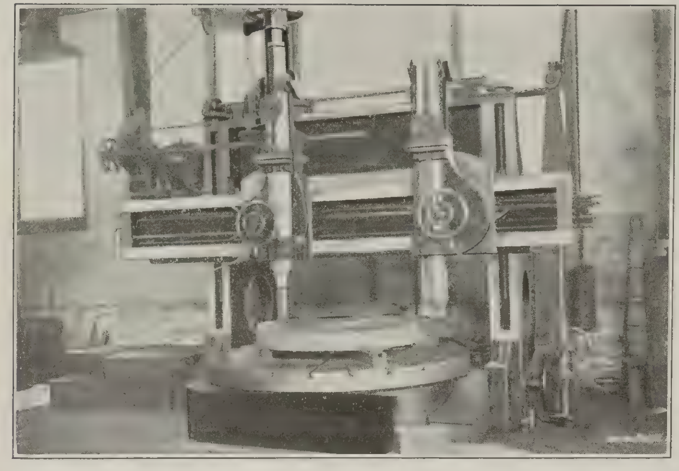


Fig. 11. Ten-foot Boring Mill with Revolving Bar used for Crank Disks.

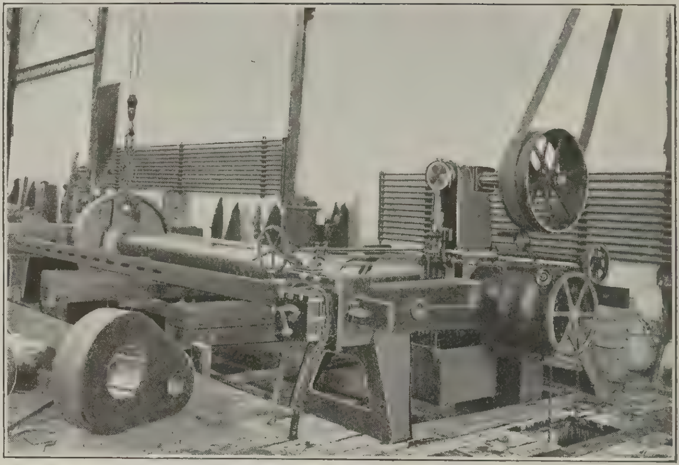


Fig. 12. Hydraulic Press, Electrically Driven.

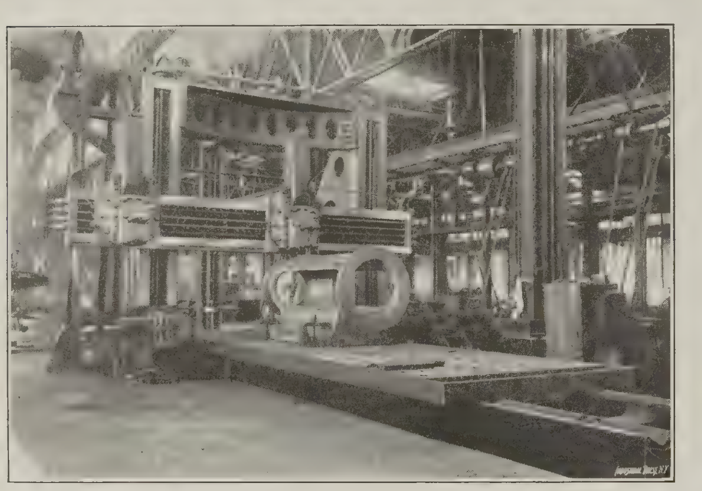


Fig. 13. Heavy 12 ft. x 12 ft. x 30 ft. Niles Planer.

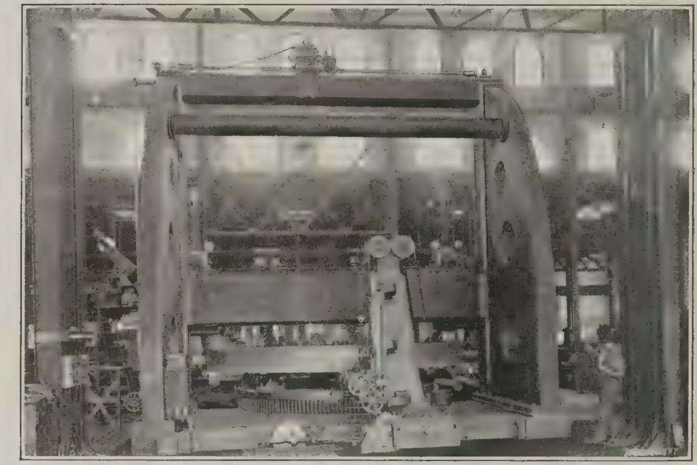


Fig. 14. Heavy 20-foot Boring Mill with Auxiliary Column.

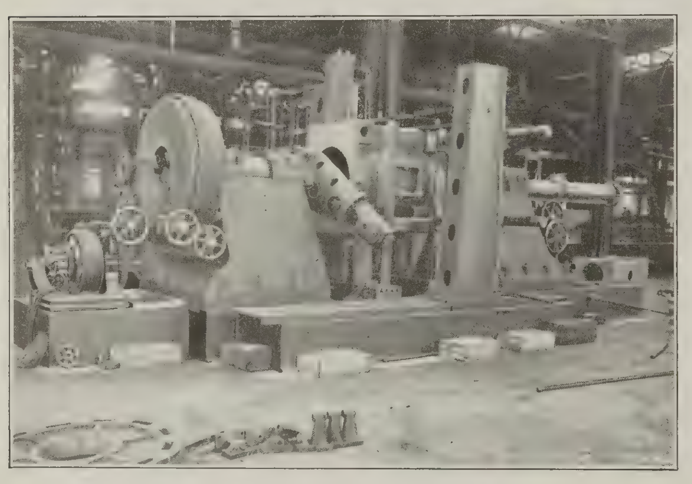


Fig. 15. Worm-driven 72-inch Cylinder and Port Boring Machine.

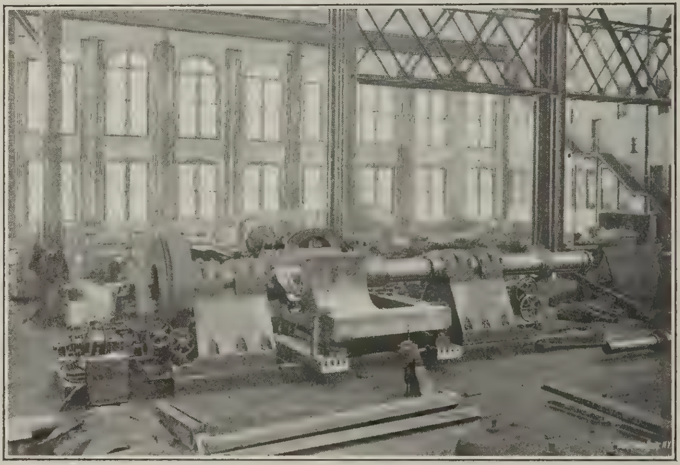


Fig. 16. Bed Boring and Facing Machine.

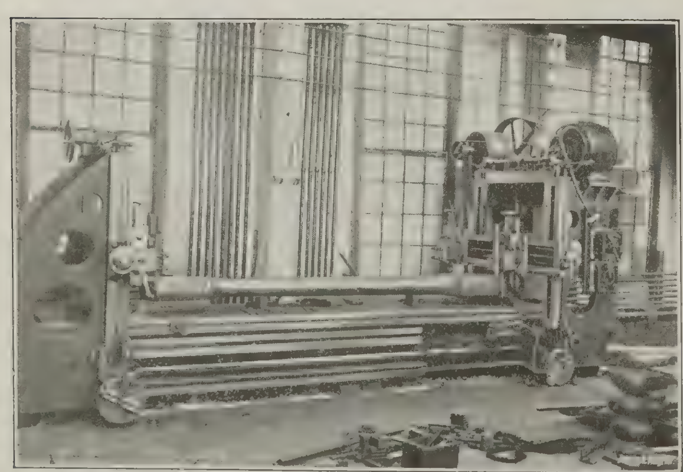


Fig. 17. Double Connecting-rod Planer.

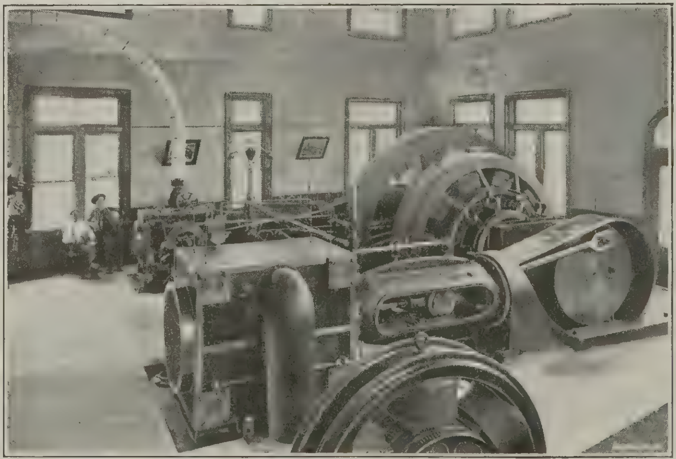


Fig. 18. Engine Room.

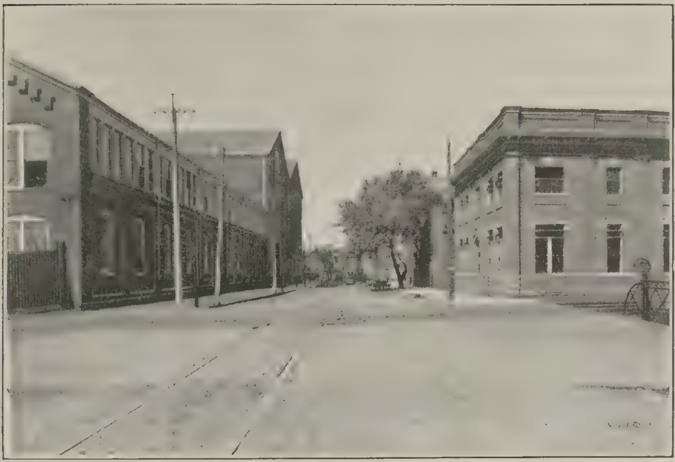


Fig. 19. Heaton Street, showing Machine Shop on the left.

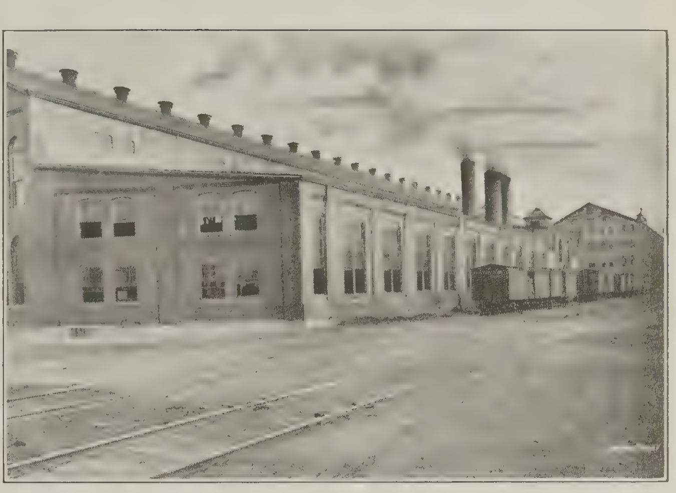


Fig. 20. View of Foundry looking South, towards Machine Shop.

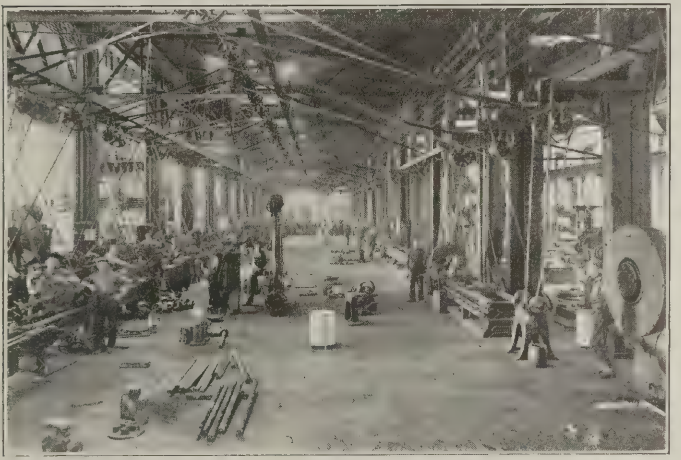


Fig. 21. Machinery Bay, with Countershaft.

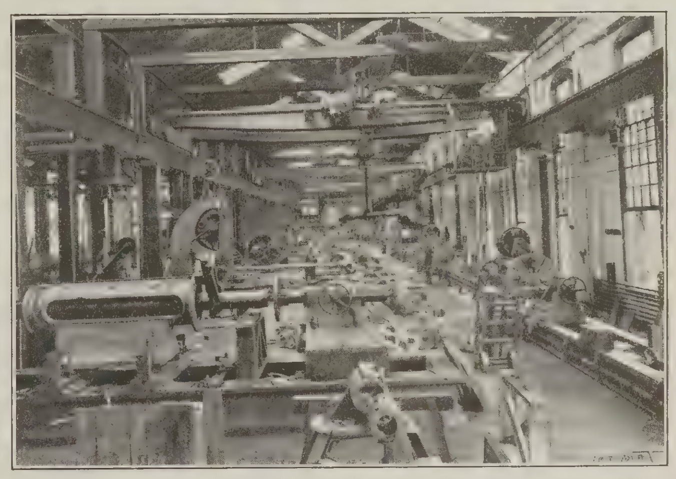


Fig. 22. Low Ridge Roof Machinery Bay, looking North.

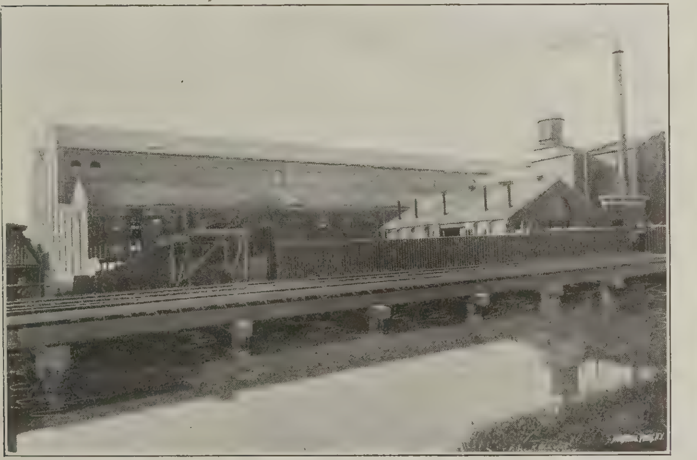


Fig. 23. View of Machine Shop from rear, showing Blacksmith Shop.

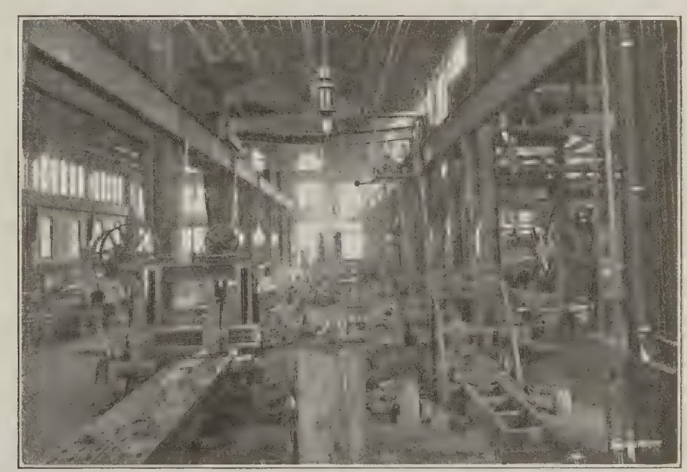


Fig. 24. Narrow Machinery Bay, parallel to Heaton Street, looking East.

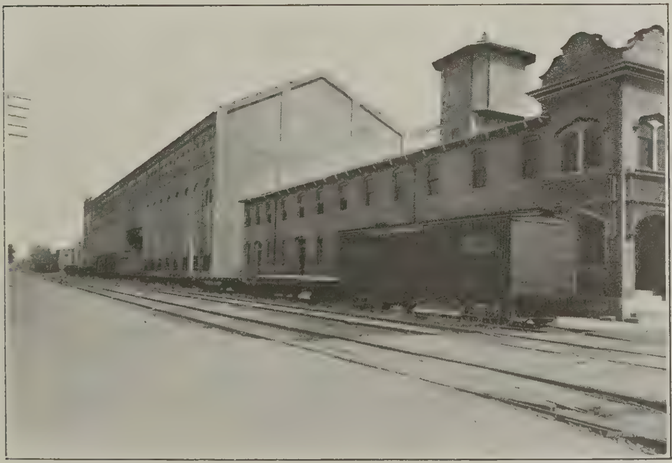


Fig. 25. New Portion of Machine Shop—Erecting Shop Side.

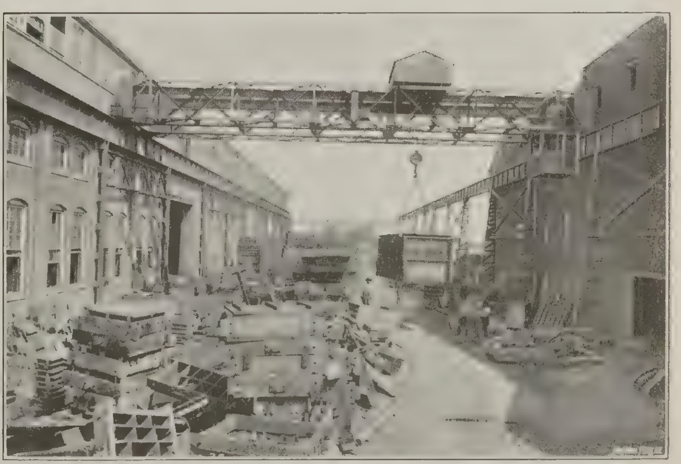


Fig. 26. Flask Yard and Traveling Crane.

view, Fig. 4. This mill swings 10 feet and has a boring bar which is used for boring crank-pins holes in crank disks, the table and disk, of course, standing still during such operations. With this machine the crank-pin and shaft holes can be bored and the disk turned and faced at one setting. This tool, it may be safely said, is about the best example of a combination machine. Ordinarily a combination tool is not much of a success, that is, those in which radically different operations like slotting and boring are conducted on the same machine.

Attention is called to the large hydraulic press seen in Fig. 12, which is used for pressing shafts into crank disks, etc., to observe the convenient manner in which electric controller and valve connections are located, all being brought to one spot, where the operator can watch the pressure gage. The press is belt-driven by a 8-horsepower constant-speed motor.

The cubic space of the various sections of the machine shop just described, which are practically all in one room, measures about 5,000,000 cubic feet, and the area of exposure is proportionally enormous. The original plans of heating proposed by Mr. Thomas G. Smith, of Cincinnati, the consulting engineer, contemplated the use of the hot air plenum system as being best suited to the needs of large open buildings such as these, but this system was finally abandoned for direct radiation from low-pressure steam coils. This action was taken partly because of the difference in cost, but largely because the company did not want the large underground ducts which would have been necessary with the hot-air fan system. Because of the great cubic space and large exposures it was quite a problem to secure the space for the pipe coils giving the necessary amount of radiating surface, and for this reason the installation is somewhat unusual, inasmuch as the most of the coils are placed vertically between the windows. This may be seen in the view, Fig. 2, where it will be observed that the proportion of horizontal piping beneath the windows is small as compared with the vertical pipes between them. Ceiling coils are also placed so as to aid the circulation and contribute to heating the large body of air in the center of the shop.

The Webster system of steam distribution is used. The steam supply from the power plant is carried across the street in the tunnel into the machine shop where the main rises to the level of the roof trusses and extends throughout the bays to supply the coils. The returns are conducted back to the tunnel in trenches near the walls of the building, and through the tunnel to the vacuum pump located in the basement of the main engine room. Branch mains, of course, are run to the pattern shop, pattern storage warehouse, and screw machine department. The exhaust of the main engine, supplemented with live steam through a pressure-reducing valve, is used for heating, so that the engine is practically run non-condensing in winter so far as any contribution from atmospheric pressure is concerned. It is only in summer when this economy can be realized.

The offices are in the northwest corner of the erecting shop, the required space being taken from the north end of the erecting bay. On the first floor are the main and private offices and the superintendent's office. The latter is so located that the interior of the shop may be seen through windows cut through the partition wall for this purpose. These rooms are handsomely finished in mahogany and present a fine appearance. The second floor is used for drawing room, and the third floor is reserved for the same purpose when a large force is being employed. A three-story fireproof vault affords safe storage for valuable papers for each floor.

* * *

A distinctive feature of electric welding is that the interior is raised to the welding temperature before the surface reaches that heat; heating in the forge is the converse of this condition. With electric welding if the exterior surfaces weld the operator is sure that the interior is also welded since it must be at a somewhat higher heat. With forge welding the surfaces may be welded perfectly and cover an imperfect job within. Unfortunately electric welding seems practicable only for comparatively small pieces on account of the enormous amperage required for large sections.

REFINEMENT OF TAPER ATTACHMENT GRADUATION.

One of the useful American improvements of the engine lathe is the Slate taper attachment by which tapered work can be turned with the centers in line, coincident with the longitudinal axis of the lathe. The general construction of the taper attachment is too well known to require any description here beyond such general outline as will serve to make the following references clear:

Instead of setting the tailstock over, thus throwing the axis of the work out of parallel with the longitudinal travel of the carriage, a guide-bar, supported by suitable brackets on the back of the lathe bed, is used to produce the desired taper. The guide-bar is pivoted so that it may be swung through an arc of limited length, either side of the line parallel with the lathe axis, and provision is made for clamping it at any required setting. The guide-bar is made with parallel sides on which is fitted a slide connected with the auxiliary cross-slide on the carriage. In later constructions the attachment is made to the cross-slide nut, thus doing away with one slide and simplifying the construction. The guide bar being set out of parallel with the longitudinal carriage travel and remaining stationary, it causes the cross-slide and tool to travel toward or away from the center of the work as the tool traverses it, thus causing the tool to turn a taper, the degree of which will depend upon the setting of the guide-bar.

TABLE I.

Taper per foot, measured Right Angles to Axis.	Included Angle.			Angle with Center Line.			Required Movement of Guide Bar Measured on Arc, Radius 15″.	Actual Taper per foot when Arc is Evenly Graduated in Divisions of an inch or Multiples of same.	Excess Taper per foot over that Indicated by the Reading.
Inches	Deg.	Min.	Sec.	Deg.	Min.	Sec.	Inches.	Inches.	
.50	2	23	10	1	11	35	.3123	.5003	.0003
.75	3	34	44	1	47	22	.4685	.7504	.0004
1.00	4	46	18	2	23	9	.6246	1.0010	.0010
1.50	7	9	10	3	34	35	.9363	1.5020	.0020
2.00	9	31	36	4	45	48	1.2470	2.0048	.0048
2.50	11	53	36	5	56	48	1.5568	2.5092	.0092
3.00	14	15	0	7	7	30	1.8653	3.0160	.0160
3.50	16	35	40	8	17	50	2.1721	3.5250	.0250
4.00	18	55	28	9	27	44	2.4771	4.0400	.0400

TABLE II.

No. of Reamer.	Full Length.	Length of Flute.	Taper per foot.	DIAMETERS.	
				Largest.	Smallest.
0	3¾	2¼	.624	.375	.258
1	5½	3	.600	.517	.369
2	7	3½	.602	.745	.572
3	8	4¼	.602	.989	.778
4	9	5¼	.623	1.29	1.020
5	10	6¼	.630	1.80	1.475
6	12	8½	.626	2.55	2.116
7	16	12	.623	3.373	2.750

Since it is common custom to designate different tapers in inches or fractions of an inch to one foot of axial length, instead of in degrees, it is the practice to graduate an arc over which the outer end of the guide-bar swings, so as to give direct readings. Thus if the machinist desires to turn a taper of ½ inch to the foot, he sets the datum line on the end of the guide-bar to the graduation marked ½ on the scale, and so on.

Now if the operator is careful to have his centers ground true and set dead in line, and to set the tool exactly on a level with the center of the work, the taper attachment should save much time in getting exact tapers, provided the graduations for the guide-bar setting are correct. But the usual practice is to graduate the arc in *equal* divisions to correspond to one-half the taper per foot multiplied by the ratio of guide-bar length to 12 inches. That is, if the guide-bar length is 15 inches from pivot to scale, the setting for, say, ¾ taper per foot, would be $\frac{3}{4} \times \frac{1}{2} \times \frac{15}{12} = $ 15-32 inch measured on the arc of the circle. But this is inaccurate since the even graduations expressed by any setting ratio, can only be laid off on the line tangent to the arc at the intersection of the line *CF*, Fig. 1. The taper per foot corresponds to the divisions on the tangents *AB*, which lie at right angles to the axis of the lathe. If, for example, the guide-bar was 12 inches long, the divisions on this line could be laid off in exact inch divisions, being marked for direct reading, of course, just double the actual length. Thus the ¼ inch line from zero would be marked ½, and so on. But, as stated, the graduations are laid off on the arc *DE*, and usually in equal divisions. Now since the equal divisions only properly exist on the tangent scale *AB*, the projections of these divisions must necessarily intercept parts on the arc which vary with the angle subtended by the axis of the guide-bar. When the angle is small the tangent and arc divisions are nearly equal, the differences being very minute, but as the angle increases the differences become marked. The change may be noted by referring to Table I. The lines *CK*, Ck_1, Ck_2, etc., in Fig. 1, indicate the position of the guide-bar for various settings up to 4 inches taper per foot.

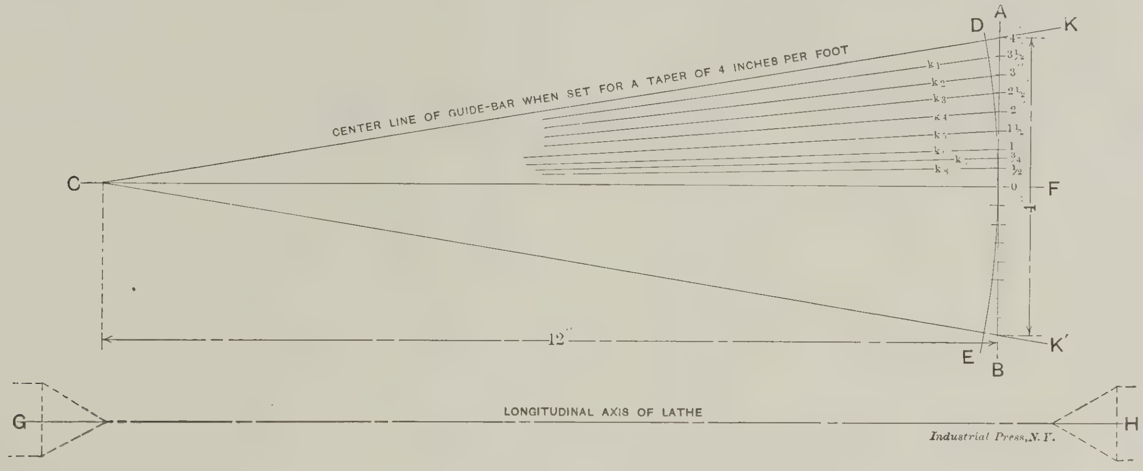

CENTER LINE OF GUIDE-BAR WHEN SET FOR A TAPER OF 4 INCHES PER FOOT
A
D
K
C
F
E
B
K′
k1
k2
k3
k4
k5
k6
k7
k8
4
3½
3
2½
2
1½
1
¾
½
0
12″
G
H
LONGITUDINAL AXIS OF LATHE
Industrial Press, N. Y.

Fig. 1. Diagram Illustrating Application of Tangent Scale.

The Bradford Machine Tool Co., of Cincinnati, Ohio, investigated this matter quite thoroughly some time ago, and, becoming convinced of the desirability of more accurate means for setting taper attachments than generally provided, they had "tangent" scales made by the Brown & Sharpe Manufacturing Co., which are now applied to all engine lathes built by them, having taper attachments. These scales are screwed fast to the end of the sector plate, being bent to the arc of the required circle, as indicated in Fig. 2, and are made for the various sizes shown in the same figure. The divisions indicating tapers in even inches are exact, being projected from the inch divisions on the tangent, as already explained in the reference to the tangent *AB*, Fig. 1. The intermediate divisions are equally spaced; that is, the space between two adjacent inch marks are divided into eight equal parts. The error thus introduced is negligible; it is the accumulated error on wide angles that the corrected scale is designed to avoid.

SIZE LATHE	DIMENSIONS	
	A	B
14	10½	2⅞
16	14	4¾
18	15	5
21	14	5½
25	17½	6
28	24	8¼
31	21½	7
32	21½	7

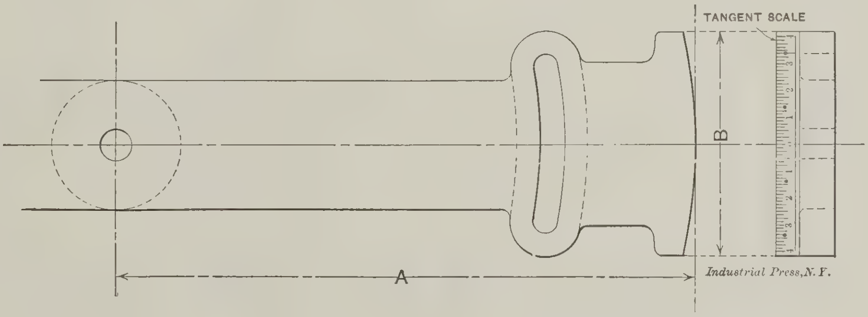


Fig. 2. Application of Tangent Scale to Bradford Lathe Taper Attachment.

The importance of having at hand accurate means for producing tapers on engine lathes to any required taper per foot, or to any angle, scarcely needs to be discussed here—it is too apparent. But as an example of the confusion and trouble that have been perpetuated because of using inaccurate methods in the past, we reproduce a table of Morse taper reamers, provided in blueprint form for use in the Bradford Company's shop, which, of course, they are obliged to follow when boring lathe spindles to Morse tapers. The Morse taper was, we believe, intended to be ⅝ inch (.625) per foot; the variation from this measurement may be noted in Table II. It is but fair, however, to state that the Brown & Sharpe standard taper of ½ inch (.500) per foot, varies in the case of No. 10, the taper in this case being .5161 inch per foot.

In addition to providing the corrected scales on taper attachments the Bradford Company expect soon to also graduate them in degrees, so that angles expressed in taper per foot or in circular measure, may be readily and accurately turned or bored by setting of the guide-bar to direct-reading scales.

* * *

Casehardening is a primitive steel-making process by which the surface of the pieces is enriched with carbon, putting it in condition to be hardened by sudden cooling. For hardening dies of complicated form, or most simple forms for that matter, casehardening usually gives more satisfactory results than plain hardening. Heating a piece of high-carbon steel in an open fire will very likely burn out some of the carbon, leaving it in a poor condition to harden when dipped. The casehardening process, on the contrary, enriches the surface with carbon and insures the maximum hardness at the surface where it is needed. It permits of the use of low-carbon steel which is cheaper and more easily worked. Another feature of the casehardening process that is particularly favorable to getting good results, is that the pieces being packed in a box and slowly heated, the heating is more uniform and the metal is protected from jets of cold air impinging against it, which we all know, is one of the difficult things to avoid in open forge heating.

MACHINE SHOP EQUIPMENT.—5.

EQUIPMENT OF THE IRON FOUNDRY.

OSCAR E. PERRIGO.

The equipment of the iron foundry necessarily differs in many respects from that of the other departments heretofore considered, as to its product, its work, and the necessary arrangements for carrying it on. These requirements, while they have changed much since the earlier plants for this work were established, have not perhaps undergone so great a change in a general way as have those of the machine shop. The early plants were, of course, very crude and primitive affairs, and iron was often melted in crucibles somewhat as brass is melted now. Most of the work done was of the plainest kind and little attention was paid to symmetrical or artistic effect.

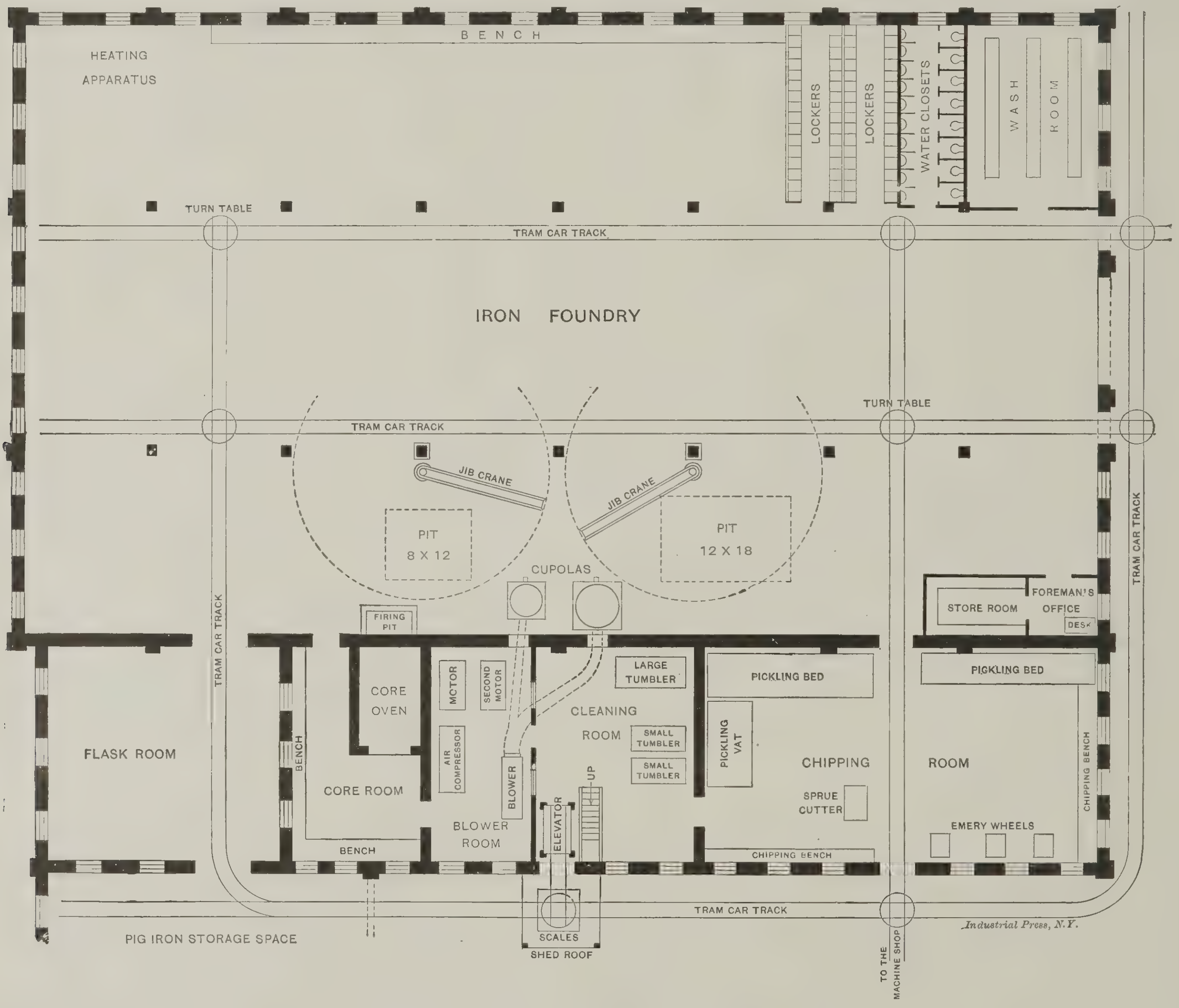


Fig. 1. Plan view of Foundry, showing General Arrangement and Equipment.

Early history shows that the making of iron castings was one of the oldest mechanical industries of the country. In the year 1643 John Winthrop arrived in this country from England, bringing with him the necessary number of skilled workmen for this purpose, and built a small iron foundry in Lynn, Mass., and the fact that the first casting which was made was "a small iron pot holding about a quart," shows the modest capacity of the foundry. The casting is said to have been made "from native ore."

Little progress seems to have been made in enlarging the original scope of the work from its early beginnings, so far as records of the facts are known. In 1735 an iron foundry was established in the little town of Carver, Mass., and a second one was built in the year 1760, wherein the historic Massachusetts Teakettle was cast.

Another foundry was built in 1793, and was burned down in 1841. The proprietors of this foundry were Bowers & Pratt. A relative of the latter partner established a foundry in Wenham, Mass., and his son, at a later date built a foundry in Watertown, Mass., which was the original of the now well-known foundry of the firm of Walker & Pratt, for whom the writer had the privilege of making the first drawings of their heating apparatus to be reproduced by the original photo-engraving process invented by Moss, and operated by the Moss Photo-Engraving Company, on Park Place, New York City. Following the gradual development of the iron founding business from the early times is very interesting, but too long a story for the space of this article.

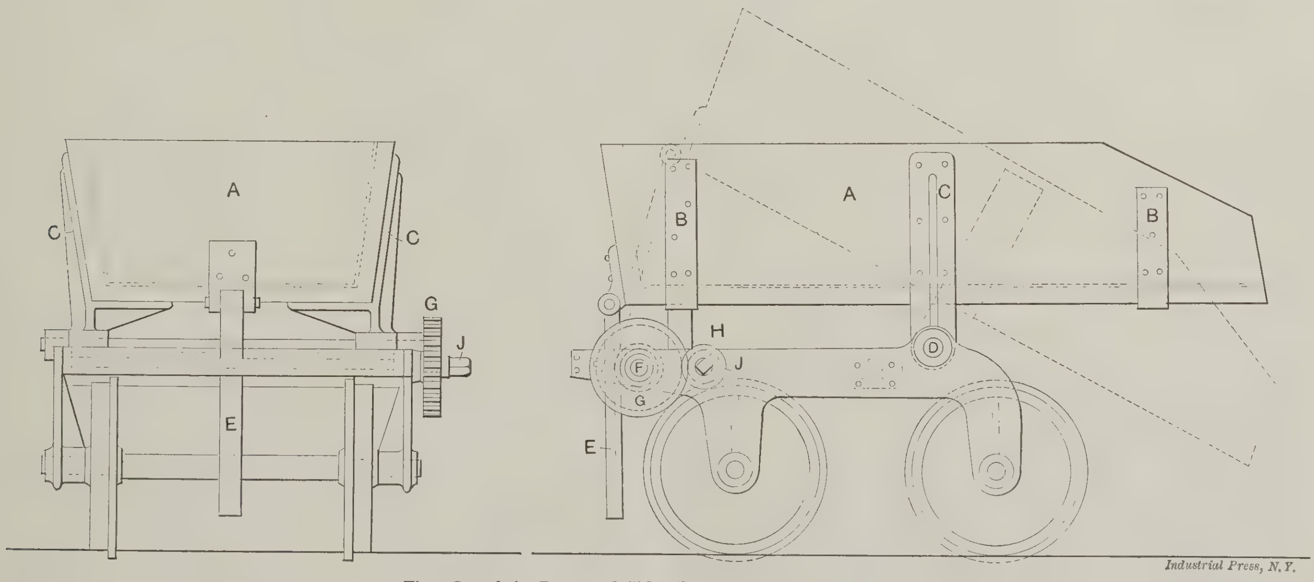
In these later years the addition of the traveling crane, the pneumatic hoist, the application of electricity, the iron flasks, the sand blast system for cleaning castings, and similar improvements have changed many of the older methods, and rendered the work less laborious and the output much larger. At the same time the quality of the work, both in its practical and in its artistic features, has been greatly improved.

The foundry floor has been particularly described in the article on floors in the series on shop construction, MACHINERY, Vol. IX., to which the reader is referred for detailed information on this point.

Fig. 1 shows the general arrangement of the foundry and its equipment. The central portion is provided with a traveling crane, and under this and the two jib cranes shown, the heavy molding and casting are done. Tramcar tracks, located as shown, bring in any stock and material, such as sand, flasks, pig iron, coal, etc., as may be necessary, upon cars specially constructed to adapt them to each class of load to be carried. Turntables are provided at the intersection of the tracks, in preference to curves and switches, as they occupy much less room, do not require any more time to operate, and the cost is nearly the same, for equipment offering like facilities. The special construction of these tracks and their accessories will be particularly described in a future article on shop transportation.

In bringing pig iron, coal, etc., to the cupolas the material is brought on the cars to the turntable scale in front of the elevator, and there it is weighed, then run upon the elevator, raised to the charging floor and the cars run upon the branch tracks, and thence to the cupolas, as shown in Fig. 2. The charging cars are specially constructed for this purpose, and are substantially the same as used by the Vilter Mfg. Company in their foundry in Milwaukee, Wis. A rear elevation of one of these cars is shown in Fig. 3, and a side elevation in Fig. 4. The frame consists of two similar iron castings for sides, held together by cast-iron cross rails bolted to them, as shown. The car body *A* is composed of two-inch planks, lined with sheet iron, and supported by wrought-iron, forged straps *B*, *B*, of U-shaped form, at the back and front, and by cast-iron angle supports *C*, *C*, near the center. Upon these supports are formed downwardly-projecting lugs, by means of which the car body is pivoted by the rod *D* to the frame, as shown in Fig. 4. The greater part of the load is placed back of this pivot, thus holding the car body in a horizontal position. Pivoted to the rear end of the car body is a rack *E*, engaging a pinion on a horizontal shaft *F*, which has fixed upon its front end spur gear *G*, engaging spur pinion *H* on the shaft *J*, which is squared on the front end for the application of a crank, by means of which the rear end of the car body may be raised and the contents of the car dumped. The dumping position is shown by dotted lines in Fig. 4. The car is of very simple construction; the gear and rack teeth are cast, the wheels and gears bored, and the hubs faced, but not turned on the outside. Several of these cars should be provided, so that there may be no waiting on the charging floor for either pig iron, scrap iron, coal or coke, during the progress of a heat, when time is valuable.

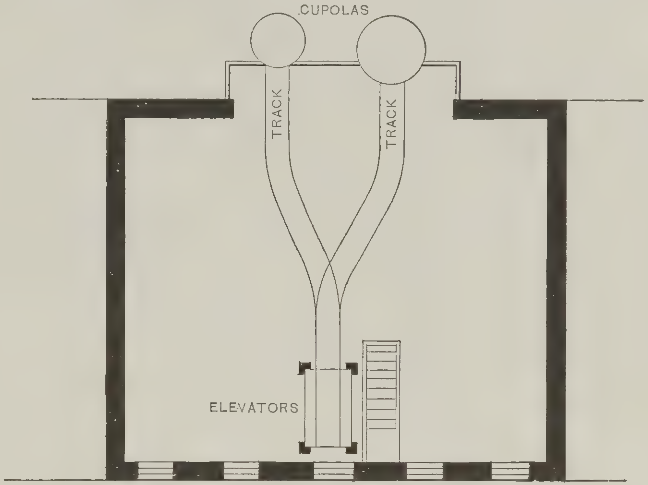
In Fig. 1 the location of the cupolas is shown, and also that of the blower and the blast pipes leading from the latter to the cupolas. A motor is also located in the blower room, which is used to furnish power to run the blower, and also the elevator, the tumbling barrels and the machines in the chipping room. It may be preferred to have two motors, one to be used only for running the blower, and run for a few hours only when a heat is on, and the other constantly, for driving the machinery above mentioned. These motors may be located side by side in the blower room, as shown. The blower may be placed on the floor, but it is often advisable to locate it overhead, out of the way of dirt and dust and more nearly on a level with the tuyeres of the cupolas, so that some of the curves in the blast pipes may be avoided, as this is a very important matter when the amount of air pressure is to be compared to the power necessary to generate it, as in this class of blowers it is considerably more than is generally supposed, even by good mechanics.



Industrial Press, N.Y.

Figs. 3 and 4. Rear and Side Elevation of Charging Cars.

The motor, or one of them, may furnish power to operate the traveling crane by the old system of a square shaft running the length of the building beside it and so providing power at any point in its travel; but this method is a rather clumsy way to transmit power, and it is a much better system to have the traveling crane carry its own motor, the current being supplied to it by flexible, pendant cables near the wall and out of the way. These should be placed on the side of the building opposite the cupolas, where there will be no obstruction to them and where they will be away from the excessive heat.



Industrial Press, N.Y.

Fig. 2. Branch Tracks for Cars to run from Elevator to Cupola.

The general molding floor of the foundry should have its work so arranged that the spaces outside of the supporting columns will be devoted to the lighter floor work and the bench work, where crane service is not needed. A bench is provided along one side as far as the heating apparatus (which occupies the outer front corner), for bench, or snap flask work. Here it will be found very convenient to use the compressed-air hoists for floor work, as it will be in other parts of the plant, as the hoists may be suspended overhead and used not only for drawing the deeper patterns but for turning over flasks, for it is now a demonstrated fact that in compressed air we have a very useful, convenient and efficient power, which may be utilized in the foundry, perhaps to as good or better advantage than in any other department of the modern manufacturing plant. Its uses are many, and the convenience with which it may be carried to any part of the floor for individual use, or for the lifting of quite heavy loads, renders it almost indispensable in the routine work of the foundry. The economy of its use may be readily appreciated when it is remembered that an air compressor provided with a cylinder six inches in diameter, and a storage tank three feet in diameter and five feet long, compressing air to 80 pounds per square inch, will furnish ample supply for a dozen hoists lifting 400 pounds or more each. In drawing patterns, turning small flasks, setting large cores and similar work, these hoists may be suspended in any desired location, the rubber hose attached bringing a supply of compressed air, easily controlled by a simple valve. These hoists may be suspended from a trolley traveling on an overhead beam, so located as to be convenient to the work. Of course, larger hoists may be used when necessary, and they are quite as effective and economical. Roughly speaking, a hoist with a 3-inch piston should lift 450 pounds; with a 4-inch piston, 800 pounds; with a 6-inch piston, 1,850 pounds; and with an 8-inch piston, 3,300 pounds. A supply of compressed air is very useful in the chipping room, where chipping tools may be very efficiently operated with it, and by its use one man may thereby do the work of at least two, and usually more.

An air compressor may be located in the blower room, as indicated in Fig. 1, and operated by the motor situated there. A cylinder 12 inches in diameter will be ample for the ordinary uses of the foundry floor and for operating such tools as are necessary in the chipping room. It will require a tank about 4 feet in diameter and 8 to 10 feet in length. This may be situated over the air compressor so as not to occupy the floor space. Such a tank should, of course, be constructed on the same lines and of like materials as a steam boiler of similar size, and to withstand the same pressure per square inch. It should be remembered that under ordinary circumstances if the air compressor is constructed on the plan of the boiler-feed pump, with a steam cylinder and an air cylinder, with one piston common to both, the proportions will be nearly these, viz.: steam cylinder, 6 x 8 inches, and air cylinder 10 x 8 inches. And also, that 90 pounds steam pressure will give about 65 pounds air pressure, with a piston velocity of 300 feet per minute. These figures are given as nearly correct and easily remembered.

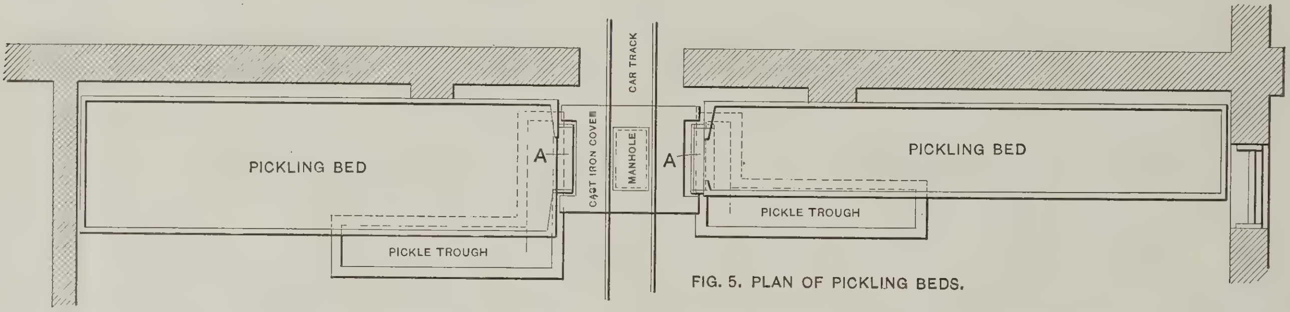


FIG. 5. PLAN OF PICKLING BEDS.

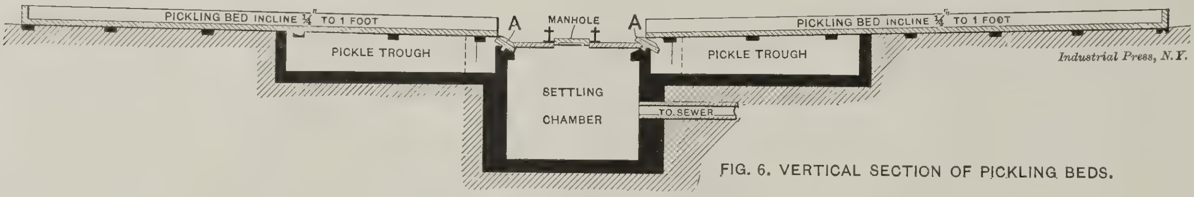


FIG. 6. VERTICAL SECTION OF PICKLING BEDS.

Figs. 5 and 6. Pickling Beds—a new and Efficient Method of Pickling.

A large variety of molding machines are in the market, many of which are admirably designed to turn out a large quantity of work in a day, and to save much of the manual labor usually necessary. They are, of course, employed on comparatively plain work where the tamping of the sand may be easily done by forcing down upon it a comparatively flat surface. They are usually employed upon the lighter kinds of work.

Molding machines are also made for molding the teeth of gear wheels of large dimensions, as well as large segments, and by their use much time is saved and the cost of large and expensive patterns for the gear teeth is avoided. There are also molding machines for pulleys, which are valuable as a part of the foundry equipment, and with a proper supply of rims and spiders this work is much simplified and the costs reduced.

These machines must be selected and provided in accordance with the particular class of work to be done, as their utility will depend almost entirely upon this matter.

Sand sifters and sand mixers are now made so as to be mounted upon a tram car and are driven by a small electric motor attached to them, the machine being thus rendered complete in itself, and may be easily moved to any part of the foundry desired, and when not in use, run out of the way. They will be found very convenient on nearly all classes of work, and may supersede the usual hand riddles almost entirely, saving much of the molder's time and producing better castings, as more sifted sand is likely to be used if the molder is not obliged to sift it by hand. Besides, being sifted close at hand, it is not so liable to contain foreign matter, as if it is sifted at one point and carried to different parts of the foundry where it may be needed.

The deep molding pits are located as shown by dotted lines in Fig. 1, one, 8 x 12 feet, and the other 12 x 18 feet. These may be of any required depth, but more usually the smaller one would be about 5 feet, and the larger one about 8 feet. All of these dimensions should, of course, be made according to the character, size and the weight of the larger castings to be made. The walls and floors of the pits should be constructed according to the directions given in the article on shop floor construction, which preceded this series. These pits will be found very useful in molding large pieces wherein a very deep nowel flask would be required, and which would necessarily raise them several feet higher on the floor than would be the case where a pit is made use of. Such pieces, which may not be cast on their side, and weighing, say, over 4 tons, will usually be found fit subjects for pit molding.

It will be noticed that the cupolas have been located within the space of the foundry proper. This, of course, will occupy considerable room on the foundry floor. They are so placed in many foundries, this being a more desirable location in several respects. In this case they come nearer to the cranes, which are supported from the main columns, and afford a convenient means of transferring a ladle of melted iron from the cupola front to the cars, and thence by the track to any point in the foundry, or, from the cranes over to the traveling crane and thence to any part of the central space of the floor. The cupolas may be located in the cleaning room and the blower room space, and thereby save about 140 square feet of molding floor space. In this case the cranes will be placed closer to the wall, but yet with sufficient reach to pass ladles of melted iron to the car track, or to the traveling crane. If this disposition is made the location of the tumbling barrels will need to be changed, placing one at the front of the room. If it is found necessary, the motors and the air compressor may be placed on the charging floor, where there is ample room for them. Even the blower may be located there, for the purpose of affording more space on the first floor, a partition dividing them from the charging floor proper. The stairs also may be placed at right angles to their position as shown, for the purpose of affording any specially desired location for the first floor equipment. In case the cupolas are placed in the cleaning room and blower room space, it may be advisable to run a car track immediately in front of them, connecting at each end with the transverse tracks by the usual turntables, and by which means ladles of melted iron may be transferred to the central space under the traveling crane by taking the route either to the right or left, as may be the shorter distance. However, many will prefer the jib crane for this service, as being quick, efficient and safe.

In the back corner of the main part of the foundry proper is the foreman's office, and adjoining it is a store room for the various small articles, tools, etc., necessary for almost daily issue, and which the foreman of a foundry of this size will probably find necessary to have under his personal control; although it will be advisable to have an employee in the office who is conversant with these matters, and to act as a bookkeeper, in order that the foreman's time may not be too much taken up with these matters of routine details.

In the front corner, on the outer side, is located the heating apparatus, which has been previously described in the general article on heating, in the series on shop construction. If preferred, it might as well be located in the corner next to the flask room. This would be convenient if more bench room was required for snap flask work.

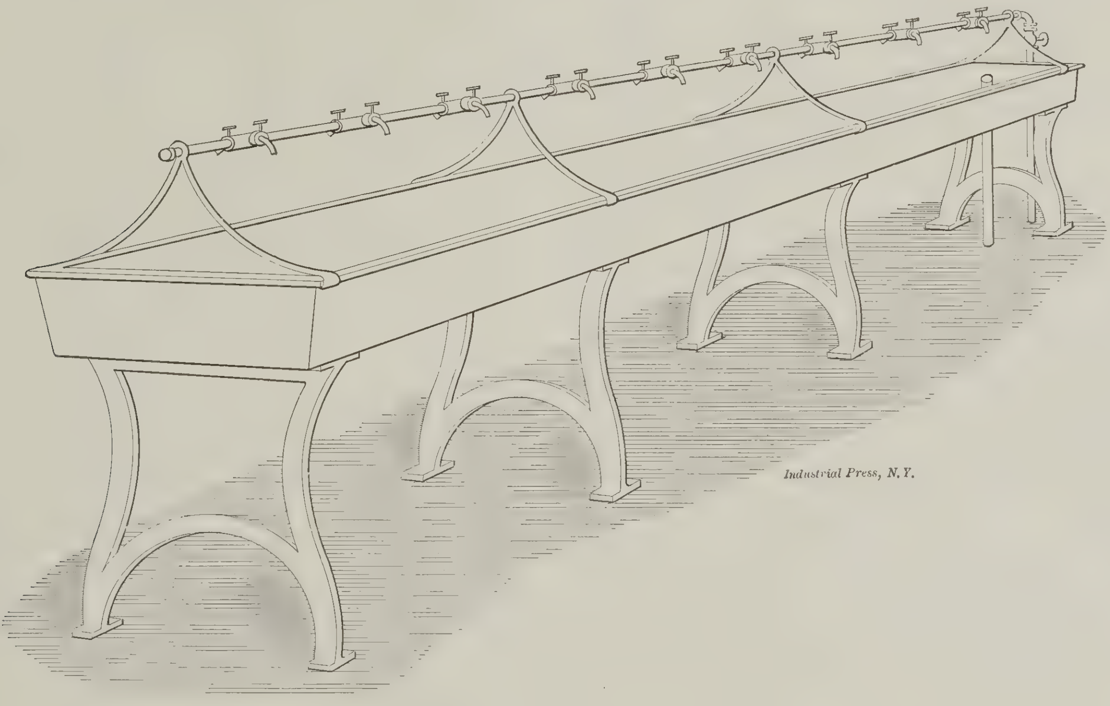


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Fig. 7. Cast-iron Washing Sinks, with Individual Supply of Water.

The chipping room is provided with the usual benches, having a sufficient number of vises on them to accommodate the work requiring hand chipping. Sprues are cut off in the sprue cutter where this can be done by such a machine. The three emery wheels will do much of the small finishing on the castings, while the pneumatic chipping tools will do very much of the work on the heavy castings.

Pickling beds are provided for, as shown on the plan, Fig. 1. These should be so constructed that the pickling solution may drain off into a receptacle where it may be saved and used again, while the water used in washing the castings after pickling, and the burned sand and scale coming from the castings, will go into another receptacle, where the sand and scale may be retained and the water flow into the sewer.

A very efficient method of accomplishing these results is in use in the new foundry of the Brown & Sharpe Mfg. Company, Providence, R. I., and with some necessary modification, it is shown on enlarged scale in the plan Fig. 5, and in vertical, longitudinal section in Fig. 6. The pickling beds are built of 2-inch plank, supported on timbers 4 x 6 inches, placed not over 4 feet centers, and have at both sides and at the upper end a plank 8 inches high. This bed is lined with sheet lead of sufficient thickness to not be easily cut through by laying castings upon it. Very heavy castings may rest upon pieces of board laid upon the lead for its protection. The lead should not be thinner than an eighth of an inch for ordinary uses. The pickle bed inclines toward the drainage system a quarter of an inch to the foot. The pickling solution or wash water dripping from the castings upon the pickling bed flows to the lower end, and upon a narrow tilting table *A*, which directs its course as may be desired. In the position shown on the right of the drawing it will run the pickling solution into a transverse conduit, from which it flows into the pickle trough, where it may be dipped up to put on other castings. When the castings are sufficiently pickled and it is desired to wash them, the hose is brought into use and the tilting table *A* is placed in the position shown on the left in Fig. 6, and the wash water flows into the settling chamber. Considerably above the bottom of this chamber a drainage pipe leads to the sewer. All sand or scale which passes down from the washing process drops to the bottom of the settling chamber, from whence it is cleared out as often as necessary through the manhole between the car tracks, as shown. A cast-iron plate covers the settling chamber, supporting the car tracks passing over it, as well as the manhole cover.

Near the pickling beds is located the pickling vat, in which small castings may be immersed until sufficiently pickled, then placed upon the pickling beds to drain and be washed. This is constructed of planks and lined with lead, the same as the pickling beds. Concrete construction may be used if desired.

An overhead trolley and hoist should be placed over the pickling beds, for removing castings from the cars and transferring them to the bed on the right or left, as may be desired, and back to the car when they are finally washed. Another similar overhead trolley should be placed in the center of the room for lifting castings to and from the floor and cars. These two trolley beams may be connected if desired, and run as one system. The hoists may be operated by compressed air, in the same manner as those in the foundry proper. If the sand blast process is to be used for cleaning castings it will be necessary to enclose a space of sufficient size in which to operate it, in order to prevent the disagreeable dust created by its use, provided the high velocity usually used is to be arranged for. There is, however, a sand blast apparatus made in Germany which uses a very coarse sand at a comparatively low velocity, which appears to be a success, and does not require to be operated in a close room.

The core room is provided with benches on two sides, and the usual form of core oven, which is fired from a pit formed in the floor of the foundry proper, by which arrangement the entire height from the core room floor is utilized for the cars upon which the cores are arranged and run into the oven from the floor level. The core oven may have its entire front closed with sheet-iron doors, running up out of the way; and upon the inner sides of the oven walls a series of supporting bars, permitting cars to run in, one above the other, their front ends being suspended on overhead trolley beams when they are drawn out. By this means the upper portions of the core oven may be better utilized and smaller lots of cores may be run in and baked at a time; or, the oven may be divided by a vertical partition and one side used for a large car, filling the entire space, and the other side arranged with shelf-like cars or racks, for small lots of cores. Separate doors should be provided to close each section so as not to expose one section to cold air when cores are to be put in or taken out of the other. By this arrangement much more work may be baked than if the whole front is to be opened at once. The doors may swing upon hinges if there is a lack of height for lifting doors, although the latter, properly balanced, form a very convenient arrangement, and not in the way when the doors are opened.

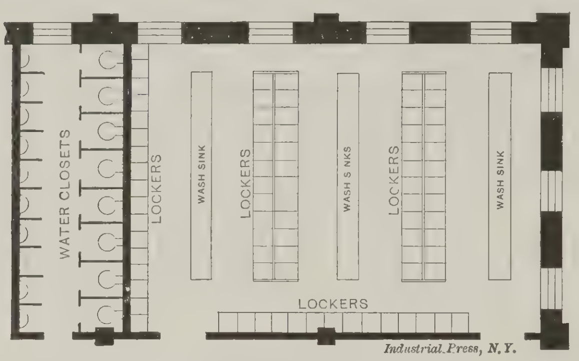

Fig. 8. Showing Arrangement of Wash Room.

The flask room requires no special arrangement or equipment beyond the car track and its cars for carrying flasks to and from the molding floor, unless a very considerable number of the flasks are of small and medium sizes, when they might be conveniently stored upon a gallery floor, which might extend nearly around the room. Flasks could be quickly and conveniently passed to and from this gallery by means of a pneumatic hoist. By this means the storage capacity of the room could be increased at least fifty per cent., perhaps more.

The wash room is located in one of the outer corners of the foundry proper, as shown in Fig. 1, and has adjoining it the water closets, and next to these the lockers for the use of the employees. The washing sinks are of cast-iron and arranged with an individual supply of water from a pipe running along above them. One of these sinks is shown in perspective in Fig. 7. By this method of water supply each man may have clean water, and still the expense of separate wash bowls is avoided. The plentiful supply of fresh water is nearly always appreciated by the men, although the writer once knew of a shop in which a similar arrangement for their cleanliness was made and the men refused to use it, preferring to wash in the common pool of not over-clean water in which all the rest of the force did the same. It has been said that "there is no accounting for taste," and this may be a case in point. Certain it is that the well-meant efforts of shop owners and managers are not always appreciated by the employees.

The water closets are arranged with a row of separate closets on one side, and a row of urinals on the other, the latter having dividing partitions 24 inches wide, while the depth of the closets is 3 feet 6 inches, and each is provided with a swinging door hung with double spring butts. The closets should be arranged so as to flush automatically, and a continual supply of running water provided for the urinals.

The lockers are of expanded metal, and are of the usual dimensions for such use, that is, 12 inches deep, 18 inches wide and 72 inches high. The width might be decreased to 15 inches and still provide ample room. They are placed in rows facing each other, with the two rows in the center back to back, for economy of space. In the plan just described it will be noticed that the lockers, the wash room and the water closets are each separated from the other. In some respects this is not as convenient as it will be to have the lockers arranged in the wash room. Such a plan is shown in Fig. 8. The amount of space and the expense necessary are about the same in either case, but the latter arrangement will probably be preferred by the employees generally, as being more convenient to have their lockers near where they are to wash up, and it will cause less confusion in running back and forth from one to the other, at a time when everyone is in a hurry to wash, dress and get out in the shortest possible time.

* * *

DEEP DRILLING.

FRANK B. KLEINHANS.

It has always been an expensive operation to drill out the interior of a hollow spindle. Indeed, it has not only been an expensive operation, but, on account of the spindle being of high-carbon steel, it has also been a difficult operation. Thus we have placed on the market hollow-drawn tubing, such as the Shelby tubing, which is intended to be furnished at a less price than one can bore out the interior of a solid bar. Of course for some purposes this tubing answers very well. But there are many cases, as in certain kinds of spindles, where such tubing cannot be used. We are obliged, therefore, to bore out this metal as best we can and endure the expense, whatever it may amount to.

Nearly all lathes nowadays must be built with a hollow spindle. This is also true of spindles of boring machines, drill presses, etc., and thus we have a large variety of work on machinery which involves deep drilling. The cost of deep drilling has been greatly reduced recently, by several manufacturers, by means of what may be termed a hollow drill. A strong flow of oil is forced through this drill against the cut, and on its return carries the chips with it, thus performing the double function of keeping the drill cool and clearing out the chips.

A perspective view of one of these drills fitted up complete for work, is indicated in Fig. 1. The body of the drill, *B*, is made of machine steel. The point, *P*, is made tool steel, and is held in position by the taper pin, *T*. A hole, *H*, is drilled in the shank, and from this hole the oil is led to slots, *S*, which are milled along the outside. These slots run the full length of the drill and then shoot down at the ends, as indicated. *F* is a flat spot for holding the drill.

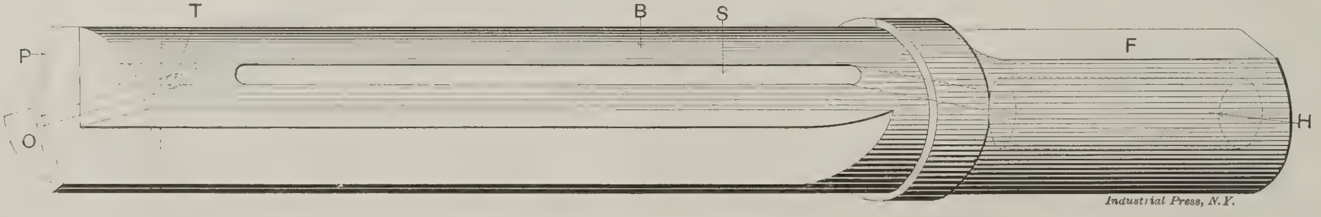

Fig. 1. Oil-tube Drill for Deep Drilling.

A longitudinal sectional view of this drill is shown in Fig. 2, from which the construction of the passageway for the oil is better seen. *H*, again, is the oil inlet hole already referred to. Two small holes, *J*, *J′*, are drilled into it in the manner indicated in this figure. The holes, *K*, *K′*, are then beveled off, and a piece of brass tube is bent in the arc of a circle and the ends are entered into the holes, *J*, *J′* and *K*, *K′*. It is then hammered down into place and the joint is flushed with solder. The slot, *P*, is milled out so as to have a semicircular bottom. Into this slot the cutter of the drill is neatly fitted. These points are best made of Novo steel, as they hold up better than under high speed. They are made as shown in Fig. 3. The hole, *H*, is reamed through the drill, while the cutter is clamped firmly back against its seat at the end of the slot. The angle, *A*, is made about 20 degrees. The cutting edge is nicked at several places, as at *N*, in order to break up the chips, this being done on the corner of an emery wheel. After the drill is put into place, it is ground up accurately to the diameter, *D*.

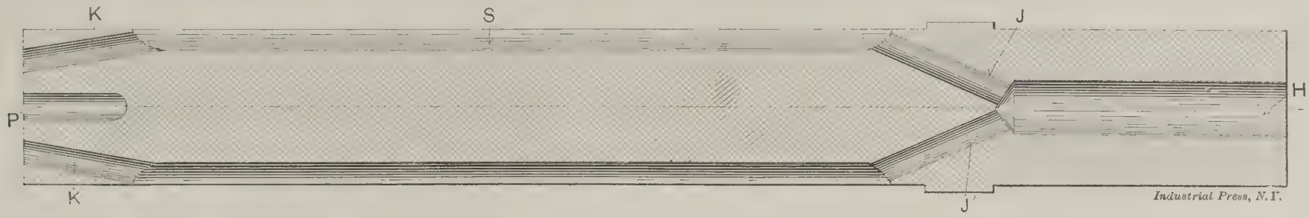

Fig. 2. Section of Drill.

The arrangement of a machine for boring out lathe spindles with this drill is shown in the illustration in Fig. 4. Instead of the long slide and hexagonal turret, a special slide, *A*, is provided, which is shaped up at the end to receive the drills. *B* is a steady-rest and *S* is the spindle. A lathe carrier is screwed into the end of the spindle, as shown, and a plate, *P*, holds the spindle up against the center by means of a few bolts. *C* is a Brown & Sharpe No. 2 pump, which is belted up to run 350 revolutions per minute. This gives an ample supply of oil for drilling a three-inch hole. A flexible tube leads from

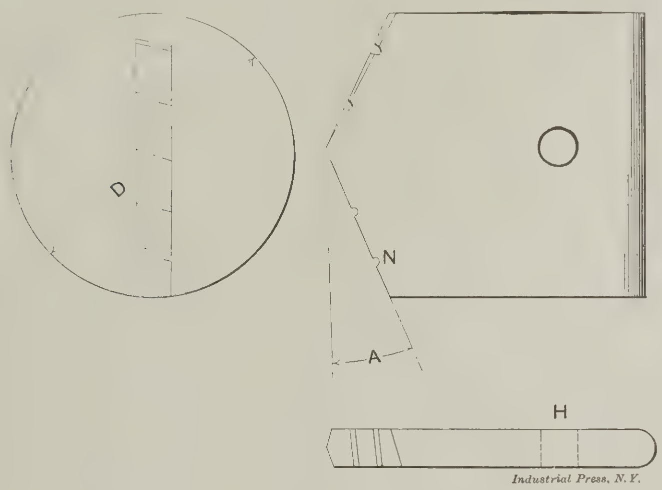

Fig. 3. Steel Cutter for Oil-tube Drill.

the spindle. The trays, *T*, *T*, catch the oil, and from these trays a pipe leads to the suction side of the pump. The drill is made long enough so as to run a short distance beyond the middle of the spindle to be drilled, the spindle being then turned round and drilled from the other end. With a drill made up in the manner explained, it is pos-

the pump to the fitting, *F*, and from thence the oil enters

sible to drill a 1 5-16 diameter hole in a .40 carbon spindle at the rate of 1⅜ inches per minute. The cutting speed would be 60 feet per minute on the longest diameter of the drill. We would thus remove the following amount of metal in a day of ten hours:

$$\frac{1.353 \times 11 \times 60 \times 10 \times .28}{8} = 312.5 \text{ pounds.}$$

By this method, a bar 28 inches in length can be drilled out at less cost than we can obtain the cold-drawn tubing of the same size.

* * *

Most failures of amateurs in machine shop photography arise from insufficient exposure. The result is a thin negative having poor printing qualities. The best thing to do under such conditions, is, of course, to take another picture, giving longer exposure or using a larger stop, but this is not always feasible. In such cases it is possible to improve the printing effect by making a transparency, using plates covered with lantern-slide emulsion, that is, plates that are specially prepared for making lantern slides. The transparency is made with the two plates placed with their faces in contact, and held in a printing frame so that the register may afterward be exactly duplicated. This is simply done by pressing each into the same corner so that a side and end are in contact with the ledges. When the transparency has been developed, fixed and dried, it is used in connection with the negative for making prints, being placed in the printing frame first, followed by the negative which is, of course, disposed in the ordinary manner with reference to the printing paper. The transparency being the exact opposite of the negative, has the effect of reducing the high lights and giving the shadows time to print the fullest possible detail.

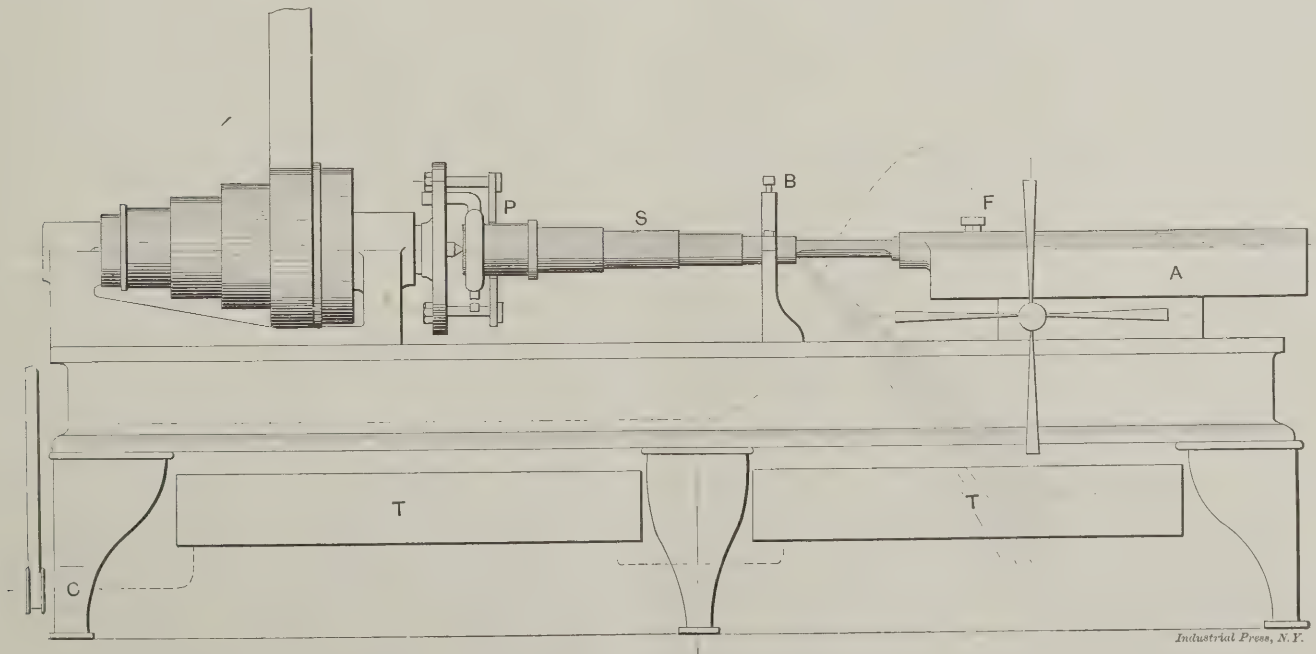

Fig. 4. Diagram of Lathe for Deep Drilling.

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Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.

LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1904.

NET CIRCULATION FOR DECEMBER, 1903,—27,217 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition, and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

Mr. George H. Hall has resigned from the editorial department of MACHINERY to again take up the work of constructive engineering. He is to be connected with the Crocker-Wheeler Company, Ampere, N. J., and carries with him the friendship and best wishes of his associates in this office.

* * *

PRESIDENT DODGE'S ADDRESS.

Mr. James M. Dodge's presidential address before the American Society of Mechanical Engineers, upon "The Money Value of Technical Training," should make pleasant reading for a young man who is trying to improve his opportunities for self-advancement. It should strengthen his confidence in himself and in his future.

Mr. Dodge believes that education pays. We probably all believe that it pays, provided the education is of the right kind and does not absorb too many of the best years of a young man's life. But the interesting thing about Mr. Dodge's paper is that he backs up his belief by statistics which demonstrate, so far as his investigations have gone, that education pays in dollars and cents. He went at the subject in a business-like manner, by selecting four groups of men, between whom comparisons of progress and advancement were to be made, and his final conclusions were derived from the average attainments of the men in each group. The first group was composed of unskilled workers or laborers; the second of shop-trained mechanics; the third of mechanics trained in schools of mechanic arts; and the fourth of technical graduates.

A statement of the manner in which the data were gathered was purposely omitted by Mr. Dodge so as to divert the discussion of his address from this feature to the more profitable question of actual results accomplished by technical training. The figures were obtained, however, in the main from the records of the Link Belt Engineering Company, Philadelphia, of which Mr. Dodge is president. The statistics of laborers represent the records of about ten years and are the averages of at least 200 men. Those of mechanics who have grown up in the shop cover a like period and were derived from about 150 men. The trade school statistics are based upon the record of 24 men selected at random from about 50 men. Those with regard to technical graduates are based on records of about 80 men who are or have been in the employ of the company. Considerable pains were taken to verify the figures by comparing them with those obtained in other establishments.

Taking the average results from each of these groups, Mr. Dodge has plotted a diagram indicating the rate and extent of advancement of each class of employees, from which we draw the following general conclusions:

The pay of the average laborer rises steadily until at 22 years of age he receives about $10 a week; and there it remains. He apparently has no resources, no initiative, no reserve to draw on to enable him to climb higher.

When we come to the shop-trained mechanic we find that his wages advance in a similar manner, but he rises higher. He has a trade to help him and does not arrive at the stationary period of wages until 24 years old, when he receives $15.80.

The trade school group averages to reach $12 a week at 19 years and $22 at 25 years. From this point on the wages do not remain stationary, as in the other two cases, although the rate of increase is small; but it is enough to indicate that the education of the trade school is of permanent help to a man in securing advancement, while a trade alone, without the education, will not, on the average, provide the means for advancing beyond a certain point.

Finally, the technical group, which advances rather slowly at first, shoots ahead rapidly after a few years and continues to climb—perhaps indefinitely. At 18 years the technical man receives only $4 a week, and at 24 years $18, but at 30 years he receives $41. As a matter of course both the trade school and technical men will at some time reach "high-water mark," beyond which their pay will not rise, but there were no statistics to indicate where these points are and it is doubtful if they could be determined.

The lesson to be learned from Mr. Dodge's address is not that a course of study will enable one to receive a stated sum of money at a certain age, and it would be wrong to assume that a course of technical study would necessarily qualify a man to draw 25 or 30 or 41 dollars a week; or even that he would receive these amounts if he were qualified. Neither is it an argument showing that a shop man may not earn several times 41 dollars a week, without even any education at all, if he has the opportunity and ability. Advancement really depends upon two things: First, outside conditions, such as the state of the labor market, influence of friends, chance opportunities, etc.; and second, the inside conditions, or what the man himself is or what his abilities are. One may and often does secure a position through outside conditions; but it generally requires ability to hold it, and Mr. Dodge has gone one step farther and has shown pretty conclusively that in the long run and on the average it requires not only ability, but knowledge to hold a good position. As he expresses it, "Trained common sense receives the greatest compensation and reaps the greatest reward," and he very aptly says, "Every man pays for the amount or percentage of bossing he requires."

It is to be hoped that other manufacturers, with statistics at their disposal relating to their employees, will have results tabulated, similar to those quoted, so that we may know whether the effects noted by Mr. Dodge in the comparatively small groups observed, actually hold in larger groups, composed of men engaged in varied lines of industry. Such a test would give the surest indication of the commercial value of education.

* * *

The manufacture of metal planers presents an almost ideal example of planer work—the platen. Naturally the tool builders making planers present a first-class showing on planer work in their own shops. Two tools working on a platen as large as that of the machine planing it, is an impressive sight, as is also the pile of cast iron chips removed in a regular day's work. In the shop of the Cincinnati Planer Company the platens are first roughed top and bottom and on the sides, and the T-slots are also roughed at the same time.

The platens are then taken to the drill press and the holes drilled for the stakes, using Novo steel twist drills running at high speed, the speed for a 1-inch drill being about 280 turns per minute. Drilling the platens before the finishing is done gives the internal stresses in the castings a chance to readjust themselves, thus preventing final changes after the finishing cuts are taken. After the finishing cuts have been planed the ways are scraped and fitted to the Vees and lastly the final finishing cut of a platen is taken on its own bed, driven by its own mechanism when being tested.

NOTES AND COMMENT.

A treatise has recently been issued, called "Technical Mechanics." The Standard Dictionary defines the word technical as "specially or exclusively pertaining to some particular art, science, trade, occupation, or the like." Mechanics is at least a branch of science, if not a science itself; so, What would non-technical mechanics be? Now let us have a treatise on medical pharmaceutics.

A number of manufacturing concerns in this country now provide their employees with a warm lunch at noon, or furnish dining room facilities where they can eat lunches brought from home in comfortable surroundings and add to the *menu* certain items like soup or coffee supplied by the company at nominal prices. This is not done as an act of charity, but is a matter of good business policy. The increased energy and better health resulting from a warm substantial noonday meal, especially with female help, has been found to more than pay the cost of such undertakings. The well-known National Cash Register Works at Dayton, Ohio, now feed about 550 girls daily, and it is their plan to eventually provide dining facilities for all their employees, who number about 4,700, during the busy season. A big catering job, that!

Notwithstanding all the arguments in favor of the worm gear, the fact remains that it is much more likely to be abused than spur gearing. The latter *can* run without oil, and, of course, in almost every instance it is better for it to do so, but worm gearing must have oil, or it will soon wear out. While it may be argued that anyone in charge of worm gearing, would run it in a bath of oil if he had any mechanical sense at all, the fact remains that machines of this type have been ruined simply by not being properly oiled. We well remember a large worm-driven butting machine installed in a structural iron works for facing off the end of cast iron columns. A pan beneath the worm, forming part of the machine, was a mute appeal for plenty of that which lubricates, but the machine was run at a period of about six months with "nary" a drop of oil in the pan, and only an occasional drizzle on the gearing, with the result that the wormwheel was nearly worn out in that period.

A not unusual procedure and perhaps the most common method of setting a gear cutting machine, is to do so by making a trial cut and measuring the height of the tooth with a gear tooth caliper. The result by this method may be right if the outside diameter of the blank is right, but if it varies a few thousandths from the correct diameter, the variation may make a noisy running gear. Again it is not the easiest matter in the world to get a correct setting in this way, even with a correctly sized blank. The Cincinnati Planer Company provide cast iron blanks, mounted on permanent arbors, for setting their gear cutting machines, which are carefully ground to the correct root diameter of the required gear. The operator places the setting blank upon the index centers and raises the cutter until it just skims the surface, which has been covered with a light coating of red lead. The setting made in this manner is very accurate, being easily within a limit of one-half thousandth inch. If the operator happens to score the surface of the setting blank it is not ruined since obviously any untouched portion of its surface can be used for setting purposes.

There are two ways of handling mechanical difficulties—one by surmounting them, the other by going around them. A well-known mechanical engineer says that sorrow and vexation of spirit is almost invariably the lot of the engineer who attempts the first mode of solution and that the easiest, and usually the best way, is to solve them by not solving them, that is, by using some other expedient equally as good, but free from the objection of the other. A case in point is that of the Manhattan Elevated Railway in New York, now a portion of the Interborough system, in regard to the third-rail difficulties in snow and sleet storms. The officials are trying to surmount the difficulty by removing the accumulations of sleet by scrapers, etc. One device of this nature is now being tried and has been found moderately successful. But its action is accompanied by a distracting screech, and it is quite doubtful if it will work successfully under severe weather conditions. The device does *not* remove the difficulty permanently—it works Sisyphus-like at a never-ending task so long as sleet is falling. The logical way of handling this problem is by preventing all accumulation of sleet on the third rail. A hooded construction presents a simple and readily built protection which has been found to successfully cope with the snow and sleet trouble in a location far worse than that of New York City.

MACHINE WORK VS. FORGING.

One of the largest steel companies in the country is employing high-speed steel for reducing forgings in a way to open the eyes even of those conversant with the rapid lathe work done in many of our machine shops. This steel company has special lathes for reducing rough forgings to the rough-turned size suitable for shipping to customers, and we are reliably informed that these lathes are of sufficient power and can carry enough cutting tools for simultaneous turning, to remove what is estimated to be thirty times the weight of metal that an ordinary heavy lathe of the same swing would be capable of turning off. The use of such massive and powerful tools, and the introduction of high-speed steels, have brought about a new condition in the production of these high-grade forgings, in that after being roughly formed from the ingot they can be reduced to approximate size more rapidly and far more cheaply by turning in a heavy forged lathe than by forging down to size under the hammer or hydraulic press. An instance has been cited to us of a forging that was reduced from 36 to 28 inches in diameter by one man working at the lathe for two days, where a gang of workmen would have been required for perhaps a day at the forge and hammer by the old method. And not only would the labor cost have been greater, but the forge and hammer would have been tied up during this time and a great quantity of fuel would have been wasted.

ELECTRICITY DIRECT FROM FUEL.

Ever since, and even before, the period when the potential force of electricity was generally recognized as a factor of great commercial value the dream of the engineer was to generate it direct from fuel without recourse to the present cumbersome and wasteful process. With the steam boiler, engine and dynamo the fuel must be fed into a furnace, where, if it is not already in a gaseous condition, it gasifies and burns at a high temperature—the higher the better, the average firebox temperature being from 2,200 to 2,500 degrees F. or more. The heat thus produced is transmitted through the shell and tubes of the boiler to the contained water which is changed into steam under pressure. By virtue of its latent heat and pressure the steam impels the piston and its energy is converted into rotary motion. Still another conversion is made in the dynamo to supply the electric current. All this is costly and inefficient, as we all know only too well. The best stationary steam plants that we know of cannot show an efficiency of one indicated horse power per pound of coal per hour, although some closely approach it. But this figure is absurdly wasteful, the thermal efficiency being only about 19 per cent., and with the best gas engines it does not appear possible to show an average efficiency of much more than 25 per cent. The efficiency of the average commercial steam plant is said to be only about 8½ per cent., and perhaps this figure is high. It is not surprising, therefore, that many of the best inventive minds have been working on the problem of direct heat conversion, the theoretical possibility of which has generally been conceded, but which has presented most formidable and baffling difficulties to a practical solution.

* * *

In a recent number N. C. B. contributed a note about different coatings for a shaft when it is necessary to pour a solid babbitt bearing around it. Mr. J. C. Green, Hackettstown, N. J., writes that he has used a simple method for years past. It is simply to rub the shaft sparingly with hard soap before pouring the bearing. He has found this plan very successful.

MEASURING EXTERNAL THREAD DIAMETERS.

METHOD OF THREAD MEASUREMENT BY MEANS OF WIRES AND MICROMETERS.

JOSEPH M. STABEL.

No doubt many mechanics who have to do with the making of taps, thread plugs and rings, often find it difficult to get accurate fits by using the tops of V-threads as points from which to obtain their measurements. Errors are almost sure to exist when measuring from the tops of the threads—points which in one sense of the word have no value at all. As is well known, the bearing of a thread is on its side and that is where a perfect fit is required. Some take it for granted that if the measurement over the tops of the threads, and that at the root, are correct the thread cannot help being a perfect fit, and no doubt they are right provided the root diameter is measured properly and the sides of the teeth are cut at exactly the right angle.

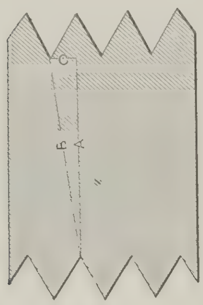
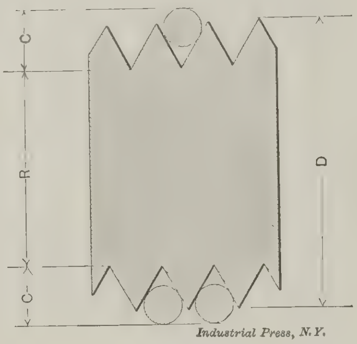


Fig. 1.



Industrial Press, N.Y.

Fig. 3.

In obtaining the root diameter it is customary to divide the constant 1.732 by the pitch of the thread, and this gives the diameter of the cylinder upon which the threads are formed, but it is impossible to measure this diameter directly, as will be seen in Fig. 1. If this is a ½ inch 12 thread screw the core diameter will be $\frac{1.732}{12} = .1443 +$ and $.500 - .1443 = .3557$, which is a measurement that must be made at right angles with the center line of the screw; an impossibility unless a pilot is turned on each piece that is to be threaded, and the thread then cut down until it comes in contact with the pilot. This, however, is not a practical method, and can seldom be followed. As will be seen in the figure the line *B* indicates the angle at which the calipers would be set in measuring this thread and it will be easily seen to be longer than the line *A*, which indicates the actual core diameter. Should the core diameter be measured on the line *B* it would be equal .3582. So when measuring the root diameter of any screw, as on the line *B*, we would have to discard the constant 1.732 and use the formula $B = \sqrt{A^2 + C^2}$.

Measuring at the top and root of the thread, however, does not always insure an accurate size of screw, as the sides of the threads may be convex or concave, thereby giving a thread that is thicker or thinner than it should be. In such a case the screw would not fit the female threaded ring properly even though the external and root diameters were accurate in size. So the method here described has been found a much more satisfactory way of measuring screw threads than by the method of measuring the apexes of the thread diameters. The measurements are accomplished by the aid of short pieces of round wire, different diameters being employed for the various pitches of threads. Fig. 2 shows the method in use and illustrates a neat fixture that is adapted to the purpose. It is composed of a regular micrometer with its anvil cut off and the frame fixed into a base plate which, in turn, rests upon three hardened legs. Great care should be taken when milling the slots into the base plate to receive the frame of the micrometer, as it must stand perfectly perpendicular with the base to insure accuracy. Upon this base plate rests the plate *b*, which serves as the anvil of the micrometer. It should be hardened, ground, and lapped on its sides perfectly parallel and is held in position by the two screws, *cc*, which fit blind holes, so that the anvil surface will be free from any obstructions. The wires are shown in position at *eee*. It is not really necessary to have this fixture as an ordinary pair of micrometers may often answer—especially for measuring fine pitch screws—but it can be easily seen that the fixture makes the work very much easier to handle.

Table No. 1 has been computed by the writer for use in connection with this method of measuring threads. It gives the measurements that are obtained by using certain sizes of wires for the certain pitch threads, both V. and U. S. Standard. It not only gives the sizes for standard threads but for numerous others with their corresponding diameters. As an illustration of the use of these tables let us suppose that a 10 pitch, ⅝-inch V-thread tap is to be cut. Following down the first column (marked diameter of screw) we come to ⅝. The next column shows the threads per inch, which in this case is 10; the third column gives the distance from center to center of adjacent threads, or .1. The fourth column gives the diameter of the wire that is to be used and then, following on to the right, the next three columns are the properties of a V-thread, and the last four of the U. S. Standard thread, giving the diameter of core, flat on threads and also the diameter of the screw at its apex of the thread angles, or in other words, the diameter that would result if the flats were omitted and the sides ran to a point; see diameter *A* in the cut. The last column is the diameter measured over the wires. As the tap is a V-thread, the fourth column shows that a .07 wire is to be used and the seventh column gives the actual size that is to be measured over the wires; which in this case is .6618, Had our tap had U. S. S. threads the size of wire would have been the same but the over-wire measurement would have been .68344.

It may be desired to measure some thread that is not found in Table 1, and for this purpose reference is made to Table 2, which gives the constants used in connection with certain sized wires on 60-degree threads. This table covers nearly all threads used, and with it the diameter required for the measurement may be easily obtained. In the first column are the threads per inch, ranging from 2 to 100, and any intermediate thread measurement can be obtained. In the upper column, running horizontally from left to right, are the different diameters of wires that may be used and under the different sizes appear the constants in line with the pitches to which they apply. The rule for the use of this table is as follows: Divide the constant 1.732 by the pitch and this gives the double depth of the thread. Subtract this from the diameter of the screw, and to the remainder add the constant selected from the table, the result being the diameter that is to be measured over the wires. The constants in this table are equal to twice the distance from the root of a 60-degree V-thread to the top of its relative size wires, as will be seen in Fig. 3, in which *CC* represent the constant, *R* the root diameter and *D* the diameter of the screw.

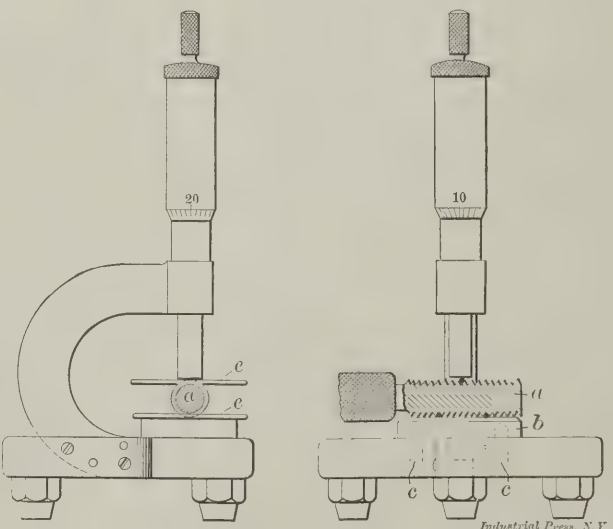


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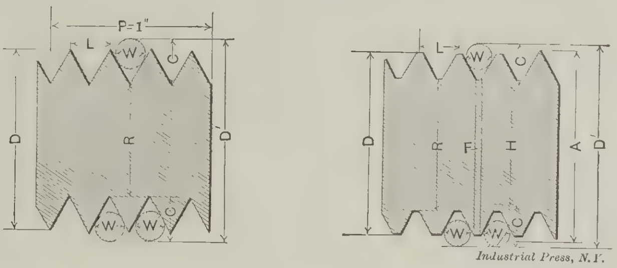
Fig. 2. Micrometer for Measuring Threads with Wires.

For example, we will suppose that a ⅝-inch, 10-thread tap is to be made by the use of Table No. 2. As diameters are not given in this table we look up 10 pitch, in the first column, and following this along to the right we come to the constant .180, and at the head of this column we note that this constant is to be used with a wire .06 inch in diameter. If we have not this size at hand we can select from three other sizes, or in other words, a ten-pitch thread can be measured with either an .060, .070, .080 or .090 wire. Having an .080 wire at hand we select the constant for this wire which in this case is .240. Following our rule we then have $\frac{1.732}{10}$ .1732 and diameter of screw equals .625 — .1732 = .4518, which is the core diameter of the screw. Then .4518 + .240 = .6918, which is the size that is to be measured over the tops of the .080 wires.

The foregoing example was for a V-thread screw but the table may be used equally well for a U. S. S. thread, the only difference being that we must consider the threads of the screw continued up to an apex thus giving a larger diameter for a certain size of screw, as will be seen in column eight

TABLES FOR MEASURING V AND U. S. S. THREADS WITH THE AID OF STEEL WIRES.



Industrial Press, N.Y.

D = Diam. of Screw.	P = Threads per inch.	L = Distance from Center to Center.	W = Diam. of Wire used.	V Threads.			U. S. Standard Threads.			
				R = Diam. of Core.	Double Depth of Thread.	D¹ = Diam. over Wires.	R = Diam. of Core.	F = Flat on Threads.	A = Diam. of Apex of 60° Angle.	D¹ = Diam. over Wires.
¼	18	.0555	.035	.1538	.0962	.2588	.1778	.00694	.2620	.2708
"	20	.0500	"	.1634	.0866	.2684	.1851	.00625	.2608	.2792
"	22	.0454	"	.1713	.0787	.2763	.1910	.00568	.2598	.2861
"	24	.0417	"	.1778	.0722	.2828	.1963	.00521	.2590	.2918
5/16	18	.0555	"	.2163	.0962	.3213	.2403	.00694	.3245	.3333
"	20	.0500	"	.2259	.0866	.3309	.2476	.00625	.3233	.3417
"	22	.0454	"	.2338	.0787	.3388	.2535	.00568	.3223	.3486
"	24	.0417	"	.2403	.0722	.3453	.2588	.00521	.3215	.3543
⅜	16	.0625	.040	.2667	.1083	.3867	.2938	.00781	.3885	.4002
"	18	.0555	"	.2788	.0962	.3988	.3029	.00694	.3870	.4108
	20	.0500	"	.2884	.0866	.4084	.3101	.00625	.3858	.4192
7/16	14	.0714	.050	.3138	.1237	.4638	.3447	.00892	.4529	.4792
"	16	.0625	"	.3292	.1083	.4792	.3563	.00781	.4510	.4927
½	12	.0833	"	.3557	.1443	.5057	.3918	.01041	.5180	.5237
"	13	.0769	"	.3668	.1332	.5168	.4001	.00961	.5166	.5334
"	14	.0714	"	.3763	.1237	.5263	.4072	.00892	.5154	.5417
"	16	.0625	"	.3917	.1083	.5417	.4189	.00781	.5135	.5552
9/16	12	.0833	"	.4182	.1443	.5682	.4543	.01041	.5805	.5862
"	14	.0714	"	.4388	.1237	.5888	.4697	.00892	.5779	.6042
"	16	.0625	"	.4542	.1083	.6042	.4813	.00781	.5760	.6177
⅝	10	.1000	.070	.4518	.1732	.6618	.4951	.01250	.6466	.6834
"	11	.0909	"	.4676	.1574	.6776	.5069	.01136	.6447	.6973
"	12	.0833	"	.4807	.1443	.6907	.5168	.01041	.6430	.7087
11/16	10	.1000	"	.5143	.1732	.7243	.5576	.01250	.7091	.7459
"	11	.0909	"	.5301	.1574	.7401	.5694	.01136	.7072	.7598
"	12	.0833	"	.5432	.1443	.7532	.5793	.01041	.7055	.7712
¾	10	.1000	"	.5768	.1732	.7868	.6201	.01250	.7716	.8084
"	11	.0909	"	.5926	.1574	.8026	.6319	.01136	.7697	.8223
"	12	.0833	"	.6057	.1443	.8157	.6418	.01041	.7680	.8337
13/16	9	.1111	"	.6201	.1924	.8301	.6682	.01389	.8366	.8542
"	10	.1000	"	.6393	.1732	.8493	.6826	.01250	.8341	.8709
"	11	.0909	"	.6551	.1574	.8651	.6944	.01136	.8322	.8848
⅞	8	.1250	.090	.6585	.2165	.9285	.7126	.01563	.9021	.9556
"	9	.1111	"	.6826	.1924	.9526	.7307	.01388	.8991	.9767
"	10	.1000	"	.7018	.1732	.9718	.7451	.01250	.8966	.9934
15/16	8	.1250	"	.7210	.2165	.9910	.7751	.01563	.9646	1.0181
"	9	.1111	"	.7451	.1924	1.0151	.7932	.01388	.9616	1.0392
1	8	.1250	"	.7835	.2165	1.0535	.8376	.01563	1.0271	1.0806
1	9	.1111	"	.8076	.1924	1.0776	.8557	.01388	1.0241	1.1017
1⅛	7	.1429	"	.8776	.2474	1.1476	.9394	.01786	1.1559	1.1785
1¼	7	.1429	"	1.0026	.2474	1.2726	1.0644	.01786	1.2809	1.3035
1⅜	6	.1666	.150	1.0863	.2887	1.5363	1.1585	.02083	1.4110	1.5723
1½	6	.1666	"	1.2113	.2887	1.6613	1.2835	.02083	1.5360	1.6973
1⅝	5½	.1818	"	1.3101	.3149	1.7601	1.3888	.02273	1.6647	1.7998
1¾	5	.2000	"	1.4036	.3464	1.8536	1.4902	.02500	1.7933	1.8969
1⅞	5	.2000	"	1.5286	.3464	1.9786	1.6152	.02500	1.9183	2.0219
2	4½	.2222	"	1.6151	.3849	2.0651	1.7114	.02777	2.0481	2.1132
2¼	4½	.2222	"	1.8651	.3849	2.3151	1.9614	.02777	2.2981	2.3632
2½	4	.2500	"	2.0670	.4330	2.5170	2.1752	.03125	2.5541	2.5711
2¾	4	.2500	"	2.3170	.4330	2.7670	2.4252	.03125	2.8041	2.8211
3	3½	.2857	.200	2.5052	.4948	3.1052	2.6288	.03571	3.0618	3.1670
3¼	3½	.2857	"	2.7552	.4948	3.3552	2.8789	.03571	3.3118	3.4170
3½	3¼	.3076	.250	2.9671	.5329	3.7171	3.1003	.03845	3.5666	3.7837
3¾	3	.3333	"	3.1727	.5773	3.9227	3.3170	.04167	3.8222	3.9949
4	3	.3333	"	3.4227	.5773	4.1727	3.5670	.04167	4.0722	4.2449
4¼	2⅞	.3478	"	3.6476	.6024	4.3976	3.7982	.04347	4.3253	4.4729
4½	2¾	.3636	"	3.8702	.6298	4.6202	4.0276	.04545	4.5787	4.6989
4¾	2⅝	.3809	"	4.0902	.6598	4.8402	4.2552	.04761	4.8324	4.9226
5	2½	.4000	"	4.3072	.6928	5.0572	4.4804	.05000	5.0866	5.1438
5½	2⅜	.4211	"	4.7708	.7292	5.5208	4.9531	.05263	5.5911	5.6119
5¾	2⅜	.4211	"	5.0208	.7292	5.7708	4.2031	.05263	5.8411	5.8619
6	2¼	.4444	.300	5.2302	.7698	6.1302	5.4228	.05555	6.0962	6.2264

Table No. 1.

of Table 1. The diameter of a ⅝-inch 60-degree U. S. S. thread with the sides of the threads brought up to an apex would equal .6466. Then we proceed as with the V-thread, by taking this as the diameter and from it subtracting the double depth of the thread and adding the constant from the table. Thus: $\frac{1.732}{10} = .1732$ and $.6466 - .1732 = .4734$, which added to the constant for the .080 wire equals $.4734 + .240 = .7134$, which is the diameter which is to be measured over the tops of the wires for a U. S. S. thread.

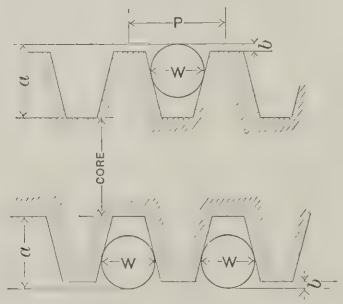
Table No. 3 furnishes the data for measuring Acme standard screw threads of the pitches most commonly used on that style of thread. In the first column is given the number of threads per inch; in the second the double depth of the threads, by means of which the core diameter may be obtained; while the third column shows the size of wire that is to be used, which equals one-half the pitch, or nearly so. In the fourth column we find the amount that is to be added to the core diameter to find the measurement over the wires, and the last column gives the amount that is to be added to the largest diameter of the screw to obtain the same measurement. The convenience of this last column lies in its making it unnecessary to find the core diameter of the screw in order to measure the thread. For example: Should it be desired to cut a one-inch screw with six threads per inch, the only computation necessary would be to add the value found in the last column to the outside diameter of the screw, or $1.000 + .00898 = 1.00898$, which is the size that is to be measured over wires .083 inches in diameter for this size and pitch of Acme thread.

TABLE OF CONSTANTS USED IN CONNECTION WITH WIRES FOR MEASURING THREAD DIAMETERS.

Threads per inch.	Diameters of Wire.																	
	.007	.010	.015	.020	.025	.035	.040	.050	.060	.070	.080	.090	.100	.150	.200	.250	.300	.350
2																	.9000	1.050
2¼																	.9000	1.050
2⅜																.750	.9000	1.050
2½																.750	.9000	1 050
2⅝																.750	.9000	1.050
2¾																.750	.9000	1.050
2⅞																.750	.9000	
3															.600	.750	.9000	
3¼															.600	.750	.9000	
3½															.600	.750		
4														.450	.600			
4½														.450	.600			
5														.450				
5½														.450				
6													.300	.450				
7												.270	.300					
8											.240	.270	.300					
9										.210	.240	.270	.300					
10									.180	.210	.240	.270						
11									.180	.210	.240							
12								.150	.180	.210								
13								.150	.180									
14								.150										
16							.120	.150										
18							.120	.150										
20						.105	.120											
22						.105	.120											
24					.075	.105												
26					.075	.105												
28					.075													
30				.060	.075													
32				.060	.075													
36			.045	.060														
40			.045	.060														
48			.045															
56			.045															
64		.030																
80		.030																
100	.021																	

Table No. 2.

CONSTANTS FOR USE IN MEASURING ACME STANDARD 29 DEG. SCREW THREADS.



Threads per inch.	Double Depth of Thread.	Diameter of Wire used.	Diameter over Wires minus Core Diameter = 2 *a*.	Diameter over Wires minus Diameter of Screw = 2 *b*.
1	1.0200	.5000	1.0836	.0636
1⅓	.7700	.3750	.8178	.0478
2	.5200	.2500	.5520	.0320
3	.3533	.1660	.3746	.0214
4	.2700	.1250	.2860	.0160
5	.2200	.1000	.2330	.0130
6	.1866	.0830	.1966	.0100
7	.1628	.0710	.1700	.0072
8	.1450	.0625	.1535	.0085
9	.1310	.0550	.1360	.0050
10	.1200	.0500	.1266	.0066

Table No. 3.

* * *

The nickel-steel alloy known as "invar," which has a coefficient of expansion of nearly zero (about 0.00000073 for 1 deg. F.) is being used to some extent by the United States Geodetic Survey in the construction of transits, but its use for measuring tapes is as yet made difficult by the fact that all nickel-steel alloys having a large percentage of nickel, are too soft to allow their use in the field for measuring purposes. It is hoped that this difficulty will soon be overcome, since promising results in that direction have been accomplished in France already. It is a consummation to be hoped for in the interests of exact measurements of base lines —the present method of using an iced bar, is very expensive and cumbersome.

TWENTY-FOURTH ANNUAL MEETING

OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The annual meeting of the American Society of Mechanical Engineers was held from December 1 to December 4, inclusive, and was characterized by an unusually large attendance. The opening session, at which the retiring president delivered the annual address, was held at the society house, which was crowded to its utmost capacity. The subsequent sessions were held at Mendelssohn Hall, New York City, and Stevens Institute of Technology, Hoboken, as the society's hall is entirely inadequate to accommodate the large number who attend the annual meetings. Social entertainment was well provided for. Besides the usual reception, one afternoon was devoted to an inspection of the immense power plants of the New York Edison Company, the Manhattan Railway Company and the Metropolitan Street Railway Company. On another afternoon Prof. Goldschmidt gave his interesting lecture upon "Alumino-Thermics," reviewed in these columns last month. The afternoon of the last day was utilized by an excursion to the works of the De Laval Steam Turbine Company, Trenton, N. J.

At the business session the report of the council was presented, covering the affairs of the society, and showing, among other things, that there was a net deficit for the year of over $1,100. In connection with this report Mr. C. W. Hunt made a statement concerning the Engineering Building project. He said that last year Mr. Carnegie attended a meeting of the Electrical Engineers and was much interested in the enthusiasm aroused by an address by Mr. Scott, the president, upon the necessity for co-operation of the different engineering societies. Finding the several great engineering societies of the country to be in good financial condition, with substantial resources, he suggested that they join forces and buy land, upon which he promised to erect a Union society house. The several organizations have since taken action upon Mr. Carnegie's proposed gift, and through funds advanced by Mr. Carnegie, have purchased a plot of ground on 59th Street, and it is now held, pending action by the several bodies.

The Mechanical Engineers have not only adopted resolutions favorable to the Union building, but have individually signed the resolutions, to emphasize the importance of the event. The Electrical Engineers and Engineers' Club have also fully adopted the scheme. The Mining Engineers, by their peculiar by-laws, were obliged to hold a letter vote, resulting in only 13 votes against the plan out of a total of 1,600 replies. The Civil Engineers were also unable to act immediately, but have had the gift under discussion and it will be voted upon in February.

To advance matters to a definite point an architect has made preliminary plans, which prove the plot of land ample for all requirements. But the estimated cost showed the million dollars to be given by Mr. Carnegie inadequate for so large a structure, and he was accordingly approached upon the subject and willingly agreed to furnish one and a quarter millions, or as much as might be necessary.

The next business was the report of the tellers to count the ballots on the amendments to the constitution and rules previously proposed, which were declared adopted.

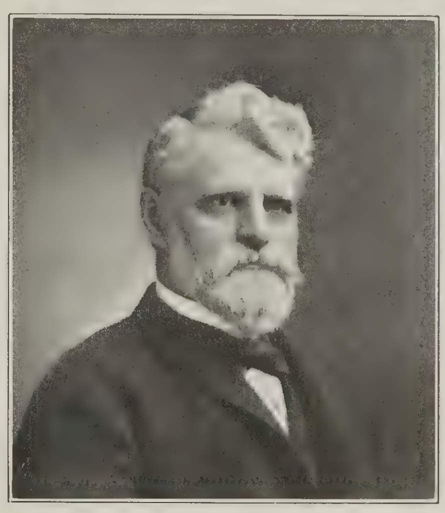
The President-elect then took the chair and in his brief remarks alluded to the formation of the society in 1880 and of a visit he then received from Prof. Sweet when the latter told him of the new society and its great advantages, and of its possibilities in the way of development.

Mr. Henry Harrison Suplee brought to the attention of the meeting the approaching twenty-fifth anniversary of the society and proposed that a historical record be prepared upon its organization, growth, books, pictures, relics, etc., and the president appointed Messrs. Suplee, Sweet and Hunt a committee for the purpose.

At the business meeting, also, the question of specifications for certain grades of steel was discussed, in view of the report of a committee appointed to confer with the American Society for Testing Materials. Mr. Henning, and Profs. Carpenter, Lanza and several others offered criticisms, chiefly against the proposal that the "yield point" be omitted from specifications.

The President for the Coming Year.

Ambrose Swasey, the newly elected president of the American Society of Mechanical Engineers, was born at Exeter, N. H., and spent his younger days in New England. His father and grandfather lived on the farm where he was raised and reached the venerable ages of 91 and 94 years, respectively. Mr. Swasey stills owns this farm and occasionally visits it in the summer time. At the age of 18 he left the old homestead and went to Hartford, Conn., to learn the machinist's trade at the Pratt & Whitney shops. He was accompanied by W. R. Warner, his boyhood chum, and now his business partner in the Warner & Swasey Company, Cleveland, O. While with Pratt & Whitney Mr. Swasey advanced to a position where he had much important work to do, particularly in the department of gearing. He developed, among other things, the machine used by this company for the production of true epicyclic curves and later his own generating and cutting machine, which is in use at the works at Cleveland. In 1880 the firm of Warner & Swasey was started, and while they have primarily been machine tool builders, they are better known to the public as builders of mountings and mechanism for astronomical instruments, particularly the telescopes at the Lick and Yerkes observatories and the naval observatory at Washington. Mr. Warner is a past president of the American Society of Mechanical Engineers, and it is highly complimentary to the firm that both its members have been able to honor the society by serving in this capacity.



Ambrose Swasey.

The Professional Papers.

In the last number of MACHINERY was published a complete list of the titles of papers presented at the New York meeting, and from these we have selected several for review in this number. Brief abstracts of these, and of the discussions upon the papers, follow:

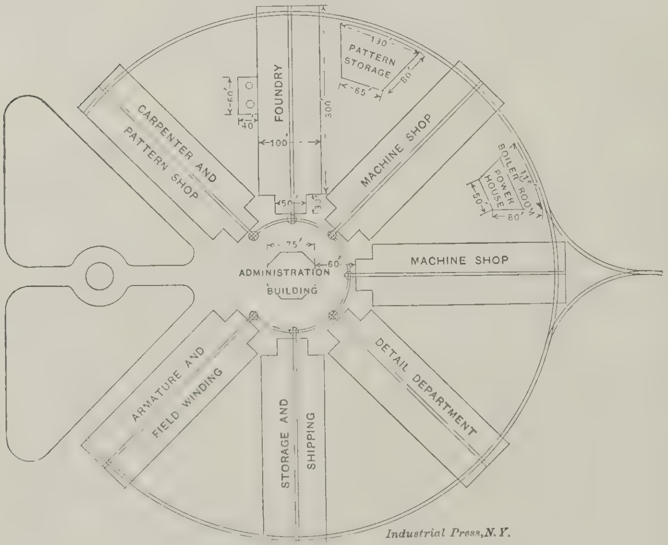
Tests have been made upon air motors and pneumatic hammers at the Aurora, Ill., laboratory of the C. B. and Q. R. R., and a paper by Max H. Wickhorst describes the apparatus used and gives the results of the tests. Those of the greatest interest relate to the power of a Vulcan pneumatic hammer, weighing 22 pounds, with a plunger weighing one pound and having an 8-inch stroke. The hammer was so placed that it would strike upward against a weight of 120 pounds, so connected with an autographic recording apparatus that any vertical movement of the weight was multiplied 8 times on the record. Tests were made with air pressures of 60, 80, 100 and 120 pounds and the distances the weight was raised by the hammer blows under the different pressures were, respectively, .004, .0052, .006 and .0065 feet. The corresponding foot-pounds per blow were accordingly, .48, .624, .72 and .7818. The strokes per minute were 834, 892, 964 and 1,000, and the horse power, found by multiplying the foot-pounds by blows per minute, and dividing by 33,000 is, for the different air pressures, .0122, .0168, .021 and .0236.

The Construction and Efficiency of a Four-valve Engine, by Benj. T. Allen, related to a type of engine in which four Corliss valves are used for each cylinder, but are positively operated by a shaft governor. Engines of this class are usually operated at medium speed, not exceeding, say 200 revolutions per minute. The particular engine under description was built by the Harrisburg Foundry and Machine Company, and is tandem-compound, direct-connected to an electric generator. The cylinders are of the ratio 1 to 7.33, after the style advocated by Mr. Geo. I. Rockwood, high pressure cylinder 15 inches diameter, low pressure cylinder 40½ inches and stroke 27 inches. There is a reheating receiver between the cylinders. The engine runs condensing at 150 revolutions per minute. The boiler pressure varied during the tests from 90 to 153 pounds per square inch and tests were conducted with loads at 1-6, 5-8, 7-10, and 1 1-10 full load. The steam consumptions per I. H. P. per hour at these several loads were, respectively, 14.42, 13.59, 12.33, 12.66 and 12.73. These results indicate a remarkably small variation in steam consumption for different loads, representing a curve of economy closely approaching a straight line.

In the discussion Prof. Carpenter questioned the value of comparisons of tests where the boiler pressure changed so greatly. He also said that while the efficiency curve, found by plotting the total steam consumption in relation to the horse power, would become a straight line in the case of a throttling engine, which runs at fixed cut off, he had never known of an instance where it would be other than curved in the case of an automatic cut-off engine.

Mr. Rockwood, however, corroborated the "straight line" performance and said that in reality this engine, while actually an automatic engine, would throttle the steam at short cut-offs, tending to make the efficiency curve a straight line. He also testified to the excellent results with other "high-ratio compound" engines, and quoted tests giving results similar to the Harrisburg engine. The author of the paper said that as the steam was throttled in any case by the action of the valve at small loads, the low boiler pressure during certain of the tests introduced no error.

Suggestions for Shop Construction, by F. A. Scheffler, outlined the layout for a manufacturing plant, on the hub-and-spoke plan. In the center of the space available for buildings is located an administration building, constituting the business, accounting and sales offices; and on the second story, the drafting room. This building is octagonal, or hexagonal, whichever may be found to be most suitable for the purpose. In this case, it has been designed with a view of accommodating seven buildings, which radiate from each side of the octagon, and has one side reserved for the main entrance through the building. The end of each shop which is nearest to the administration building has its individual office for the foremen and shop clerks.



Industrial Press, N.Y.

Novel Arrangement of Manufacturing Plant.

The general arrangement gives each shop plenty of yard room, which is also very essential; and traveling cranes, either worked by hand or power, could be located in the yard room between any two of the shops, for handling raw or finished material.

A circular track around the administration building connected in front of each shop building by means of suitable turntables, worked by hand or power, makes the distribution of material between the buildings very easy, and it will be noticed that the distance the material will have to travel from any one building to another is comparatively short.

At the extreme outer end of each building is another circular track, primarily to be used for shipping purposes, and the distributing of such material as may come in or go out over the connecting railroad lines. This track runs through the end of each building; and in such buildings where the machinery, castings or other goods are to be handled, the heavier traveling crane in that particular building which should run the length of the shop, can easily unload or load the cars. This arrangement makes it possible to go into every shop without having a multiplicity of tracks and switches, thus cutting up the available yard room, as is usually the case in ordinary plants. It is also possible, if there is sufficient ground available, to extend any one or all of the buildings, and still retain the best features of the design.

In commenting on this construction, Mr. Suplee mentioned a penitentiary in Pennsylvania built on this plan, the guard house being at the center. A series of mirrors near the central portion of the guard house made it possible for an attendant sitting in a certain position to see what was transpiring in any of the radiating corridors without leaving his post or even changing his position.

"A compact Gas Engine, Beam Type," was the subject of a paper by C. H. Morgan. This engine is now being built and is designed in a way to minimize the lateral pressure of the piston on the cylinder walls. We shall not attempt to illustrate this engine at present, but there were several interesting points brought out in the discussion which will be referred to.

Prof. Sidney A. Reeve said there is a false impression that a blow is struck in a gas engine cylinder by the combustion of the gas. On the contrary, this is not so much the case as in the steam engine, considering the pressure at which the engine operates. In designing a steam engine for a steam pressure of 400 pounds per square inch, the pressure at which a gas engine works, there would be more trouble than in a gas engine, because with the former steam is admitted full pressure at the beginning of the stroke. He showed pressure diagrams, indicating the pressures sustained by the pins and bearings of gas and steam engines.

Mr. Thwait, the English engineer and gas engine expert, also corroborated this statement. Mr. E. A. Uehling presented data upon blast furnace gas. Above the requirements of the blast furnace and the heating of the blast there are 840 horse power per ton of iron produced available for outside purposes. In one plant 20,000 horse power answered requirements for blast furnaces, and there might be 18,000 horse power for sale in addition. While the amount of available power from different plants varies, in no case had he found it less than 800 horse power per ton of iron manufactured per hour. Though blast furnace gas is a lean gas, it is a very valuable gas for power purposes. When illuminating gas is used in a gas engine, there must be added 9 times the quantity of air while with blast furnace gas air need be added only about in the ratio of 1 to 1. In blast furnace gas there is only about 25 per cent. of combustible as against nearly 100 per cent. in illuminating gas; but when it comes to the final mixture of gas and air the illuminating gas will be found to have nearly 80 per cent. of nitrogen mixed with it and there will be more inert gas than with the blast furnace mixture. Besides the illuminating gas cannot be compressed to so high a pressure and is not so economical to use on this account.

In some respects the most important paper of the meetings was the report of a test by Prof. D. S. Jacobus upon a Rice and Sargent steam engine, using superheated steam. This is the first American-built engine of importance upon which tests have been conducted and reported before the society.

The high pressure cylinder of the engine has double-beat poppet valves and the low pressure cylinder, Corliss valves. The inlet and exhaust valves of each cylinder are operated by separate eccentrics. The inlet valves are closed by vacuum dash pots and the exhaust by a positive motion. A portion of the highly superheated steam furnished to the engine passes through a coil in the receiver between the high and low pressure cylinders. The cylinders are 16 and 28 by 42 inches. The steam is superheated in an independently-fired Schmidt superheater. With superheated steam the water consumption per horse power hour was 9.76 pounds at 474.5 horse power, 9.56 pounds at 420.4 horse power and 9.70 pounds at 276.8 horse power. The pressure of the steam at the engine throttle was slightly over 140 pounds per square inch, and the superheating from about 350 degrees to 400 degrees Fahr. The vacuum measured near the engine ranged from about 25 to 26 inches of mercury.

With saturated steam the water consumption was 13.84 pounds per hour per horse power at 406.7 horse power. In this test the vacuum was poorer than in any of the others, being 24.5 inches. It must also be borne in mind that the engine was built for superheated steam, and the cylinder ratio was not what would be used for saturated steam.

The coal consumption per hour per indicated horse power for superheated steam was 1.265 pounds at 475.5 horse power, 1.257 pounds at 420.4 horse power, and 1.288 pounds at 276.8 horse power. For the test with saturated steam the coal consumption was 1.497 pounds per hour at 406.7 horse power.

The coal consumption forms the most accurate basis for comparing the efficiencies of engines using saturated and superheated steam, because when the coal consumption is obtained it allows for any difference in the economy of the combined boiler and superheater from that of an ordinary boiler.

In the test with saturated steam the coal consumption was about 19 per cent. greater than that obtained at the same power with superheated steam. This does not form a proper basis of comparison, however, for the two reasons already stated, which are that the engine was not built for saturated steam and that the vacuum in the test was not as high as it should have been. An engine of the same general type built for saturated steam, but of about twice the power, was tested by the author and the results were embodied in a paper presented by him at the Saratoga meeting. The vacuum in this case was exceptionally high, being over 28 inches. If the vacuum had been about 26 inches, as in the present tests, it is probable that the coal consumption on the basis already given would have been 1.42 pounds per hour per horse power. As the minimum coal consumption with superheated steam was 1.257 pounds per hour per horse power there is a gain in favor of using superheated steam of .163 pounds per hour per horse power, or the larger steam engine using saturated steam is about 13 per cent. less economical than the smaller one using superheated steam.

Mr. Rice, of the firm which built the engine, called attention to some of the details of construction. The poppet-valve seats are surrounded by live steam to avoid trouble from difference of expansion of valve and seat. The stuffing-boxes are on long necks, to remove them further from the heat of the steam. The valve-gear is of the Corliss type, but with independent linkage to give full closing and avoid slamming.

The cylinder ratio of this engine was the subject of some discussion. The ratio of high pressure to low pressure cylinder volume is about 3 to 1, which ratio was copied from European practice in superheated steam engines. Professor Jacobus stated that it might be found that lower cylinder ratios need to be used with superheated than with saturated steam, but that there is yet no definite knowledge on this matter.

"What are the New Machine Tools to be?" was the title of a paper by Prof. John E. Sweet, which we reprint in full. In the discussion, Mr. Howard P. Fairfield reported the results of work of students at Worcester Polytechnic Institute with high-speed steel. Tools of certain brands of this steel were given students to use in 14-inch and 16-inch lathes. They were told to first break down the tools, if possible, and then reduce the speed and feed until a desirable balance was reached. On diameters of about 2 inches the lathes were not able to make good. The trouble seemed to be confined entirely to the headstock and carriage and most of the trouble seemed to be due to lack of material in the headstock itself. At the diameters turned a high speed was needed to give the necessary surface speed. He finally put on a heavy faceplate of large diameter to prevent tearing the headstock to pieces. The faceplate absorbed much of the jar and vibration due to the heavy cut. Mr. Fairfield suggested that the engine lathe needs more material in its headstock, broad surfaces in its carriage, which should be nicely gibbed, a positive drive to its feed works, a less number of steps on its cone and wider belts, and a massive faceplate.

* * *

WHAT ARE THE NEW MACHINE TOOLS TO BE?

A. S. M. E. PAPER BY PROF. JOHN E. SWEET.

It is a fact quite apparent to users of machine tools (and first among them are the machine tool builders themselves) that the new high-speed tool steel calls for a redesigning of our machines if we are to get even a fair share of the ultimate possibilities which the new steel offers.

I expect the machine tool builders have already the reply formulated as follows: "You just keep on building engines and leave the machine tool business to us." But that will not quite do. If no one but the engine builders had mixed in the engine business, we would have had no turbine engines, and many of the standard machine tools were originally devised by those who had use for them, rather than by the man who devised things to sell.

I think the machine tool builders will admit that the machines must be redesigned; but to the most of them will this mean anything but just to make the driving elements more powerful and the machines stronger, which is as much as to say everything has been all right, and all we need to do is to change the strength and power. But have they been all right or half right?

It can be shown by figures, I suppose (I know it to be a fact by a trial with models), that a complete box is thirteen times more rigid against torsion and four times more rigid against bending than the same amount of material is in the form of side plates and thin cross girts. It is probably from four to eight times more rigid than the cross girt plan in any form, and yet in the case of lathes, the whole business of whose beds is to resist torsion, only one or two builders have had the courage or audacity to adopt the box form.

All planer beds can just as well be box beds with half the cost in patterns and foundry work, and so, too, the tables which are sprung by bolting down work can just as well be box tables four times as strong with the same material, and with a saving of half the cost in patterns and something in the foundry.

The whole tendency of the cut is to slide the work endwise of the planer bed; but who has ever tried putting the slots crosswise in a way to offer the greater resistance and prevent the bending of the bed by the peening of the upper surface, as now occurs, which, with the springing by bolting down the work, are the primary causes of cut ways.

Some planer and boring mill cross rails are of box section in the center, but are thinned down at the ends when fastened to the housings. The most of them are three sides of a box only, or one-tenth the strength of a box, where a plain square box straight through is infinitely better and cheaper. Of course the boxes are not to be proportioned from what is in use now, but from what is to be made to meet the new conditions. To select enough material to meet the new demands and then put the material so that it will be four times more rigid will be something like it. Housings of box section will be just as rigid fore and aft and much more rigid against side strain.

Milling machines of the planer style are constructed like planing machines, seemingly without a thought but that the conditions are identical, while they are not. If the bed of a planing machine and the table were of the same length, the weight of the table and the load overrunning the end of the bed would soon wear the top of the bed crowning and the under side of the table concave to fit, and it is to counteract this tendency of gravity to wear them out of true that the beds are made longer than the tables. With the milling machine the load is less, more of it in the middle of the table, because there is less gained by putting on small pieces end to end, and the down pressure of the big cutter always in the middle partially, if not wholly, neutralizes the tendency to wear out of true by gravity. When such a machine has side cutters or a vertical spindle, the pressure is always in the middle, first in one direction and then the other, exactly the reverse from the gravity action, and instead of the side guide of the bed being longer than the table it should be shorter, by just about the same amount as the bed of a planer needs to be longer.

Many times the sliding piece and its guides can be the same length and keep straight. The things which do not tend to wear out of true do not wear much, and the things which do wear out of true and have to be refitted are never just right except when new and when so refitted. Where a short block slides on a long guide, if the scraper marks wear out sooner along the middle than at the ends, the ends of the guide need cutting off, however much overrun it gives to the sliding block.

The draftsman dare not make a drawing of an engine crosshead overrunning the guide one-third of its length at each end; the builder would hardly dare to build it if he did, and no user has the courage to take out the guides and cut them off or cut away the surface even when he knows it would be money in his pocket, but it is the thing to do. We find that in the case of a slipper guide, owing to the effect of inertia and momentum giving a twisting action to the crosshead, it is necessary to cut away the guide so that the crosshead will overrun very nearly one-half its length before the scraper marks will show uniform wear. This, of course, is subject to modification according as the center of gravity is higher or lower, or the speed of the engine is greater or less. We are building engines with the cross-heads overrunning that way and people buy them.

To get the best out of machines, they not only want to be rigid and true, but the drive needs to be powerful. In this respect a worm gear is about as perfect as can be, or cutting spur gear teeth spiral accomplishes about the same result. What appears as an objection to spiral teeth is end thrust against the shoulders, which does not amount to much, and when the shaft runs in reverse directions and end play in the journals is permissible, the journals keep in much better condition. The mention of a worm gear is like the flaunting of a red rag to some people, but it has its place and a good many more places than it has been used in. The claimed objection is excessive friction and loss of power, but the results do not seem to justify the claim.

The most perfect worm gear we have (theoretically) is a screw and nut, and they do waste enormously in friction, and in proportion to what they do they wear out the most of any piece of mechanism. The most imperfect worm gear we have (theoretically) is the Sellers planing machine drive, and yet they never wear out, and hence cannot lose much in friction.

In the writer's opinion two of the things which never need to have been invented are the Hindley worm gear and a machine for hobbing worm gear. Experience convinces the writer that a liberal pitch worm skewed round so as to properly mesh with a plain spur gear, or one with the teeth at such an angle as to skew the worm a little more, will run more easily and last longer than the other sort. A machine driven with the worm is positive, and if there is any chatter it comes from elasticity in the spindle or the work itself. The value of lathes, particularly those used for face plate work, is considerably improved by having large and short main bearings. They should be large to resist torsion and short to resist bending, and the ordinary face plates are ridiculously frail. To get the best of a face plate it should be box section and as large as will swing in the lathe.

Owing to the rapid wear of screws the writer is convinced that a precision screw in any lathe used in manufacturing is of no special value over a fairly good one. Wearing the screw in one place while threading a few hundred pieces destroys the precision in a way which no future use will ever correct.

If the designer will analyze every detail he will find that many of the old features were not right to meet the old conditions and are not half right for the new.

While manufacturing is going to call for many more simple machines—that is, machines to do one thing rapidly and well—the machines which will do a variety of work will be still in demand, for the sparsely settled sections of the country and the colonies will call for the country machine shop as of old.

It is the hope of the writer that this tirade will bring out an interesting discussion on machine design and the capabilities of the high-speed steel, for that is the object of its presentation.

* * *

THE REID PROCESS FOR PRODUCING ELECTRICITY FROM FUEL.

There have been many types of apparatus devised for producing electricity direct from fuel, either by the thermo-electric process, such as by the use of the thermopile, or by an electrolytic process, in which some form of battery is employed. All have so far been commercial failures, but it will nevertheless be of interest to describe a new apparatus for this purpose, a demonstration of which was recently made at Newark, N. J., before a party of engineers and representatives of the press. The apparatus is the invention of Mr. James H. Reid, of Newark, and apparently the demonstration was successful; but not until a test has been made by expert and disinterested engineers, which Mr. Reid promises will be done in the near future, can any prediction be made as to the merits of the process. The following description is in accordance with the statement given us by the inventor.

The Reid process of generating electricity from fuel is electrolytic, the apparatus being essentially a gas battery in which hydrocarbon gas is oxidized. The oxidation takes place in an alkaline electrolyte between carbon and iron electrodes, and sets up an electromotive force of 9-10 volt per cell. The temperature of oxidation is low compared with that of a firebox, being only about 392 degrees F., and the action is comparatively slow. "Minute subdivision and slow oxidation" expresses a fundamental principle of the process. When the fuel is converted into a gaseous state it is, of course, minutely subdivided, and since the oxidation takes place at a low temperature, it takes place slowly.

When ordinary illuminating gas, containing, say, 650 B. T. U. per cubic foot, is used, it is diluted with about 40 parts of air to one part of gas, so as to always maintain an excess of oxygen. The mixture is forced through the electrolyte under a slight pressure, about 4 pounds per square inch being used for the demonstration. Since so poor a mixture is used it is at once apparent that producer or blast furnace gases can be used. All in fact are too rich and must be diluted with air for use. An evanescent gas like producer or blast-furnace gas is said to be better than the more stable illuminating gas. The electrolyte, as stated, is alkaline, being composed mainly of sodium hydrate (caustic soda), a small quantity of iron oxide, and a little calcium chloride to absorb moisture.

Referring to Figs. 1 and 2, which show end and side sectional views of an apparatus after which substantially the commercial machines will be patterned, *A* shows the lower part of the shell, and *B* the upper part. These parts are separated by insulation and form the positive and negative poles, the connection for the wires being shown at *A'* and *B'*. The lower part *A* forms a trough containing the alkaline electrolyte and the iron electrodes *I*, *I*, *I*, etc., and from *B* are suspended the carbon electrodes *C*, *C*, *C*, etc. The carbon electrodes are made in the form of hollow plates having porous walls through which the gas entering the holes in the tops, from the chamber *D*, may filter and mingle with the electrolyte. A top view of a carbon plate, showing the holes for entrance of gas, appears at *H*, and a bottom view at *G*. As the carbon and hydrogen of the gas combine with the oxygen of the electrolyte, the latter begins to froth or foam and rise in the pipe *O*, from which it passes through the space *P*. (This portion of the cut is diagrammatic. The free air inlet *K*, and exhaust for uncombined gas *J*, are actually one, strange as it may seem. The interchange takes place through a diaphragm, *R*, *R'*, composed of alternate layers of canvas and iron wire cloth.) Here the electrolyte is said to take in some oxygen to replenish its exhausted supply. The most of the necessary oxygen is supplied with the gas, however. The iron oxide acts as an oxygen carrier in much the same manner as the red corpuscles of the blood. In fact Mr. Reid points out that his process is a mechanical parallel to that which takes place in animal bodies, i. e., carbon is oxidized at a low temperature in the lungs, the blood acting as an oxygen carrier. The chamber *P* and diaphragms in a measure correspond to the lungs, and the electrolyte to the blood. The circulation of the electrolyte is in the direction of the arrows, passing down through the pipe or passage *Q*. The gaseous products of oxidation and the unconsumed gas escape at *J*, but are not wasted in the commercial apparatus.

The pipe shown at *F* is primarily for admitting water to flush the apparatus when cleaning out; it is also used for admitting a small quantity of water when first starting it into purpose. The gas retort is not shown in Figs. 1 and 2. When the machine is generating electricity, that is, when gas is admitted, the oxidation process forms CO_2 and H_2O, the latter being water in the form of steam, which helps to keep the balance of water required in the electrolyte, but water is added from time to time.

As already stated, the electromotive force generated is 9-10 volt per cell: to get 9 volts ten cells must be connected in series. From this it is apparent that, commercially, it will not be feasible to generate high voltages direct; but any voltage can, of course, be obtained with circuit breakers and static transformers in the case of alternating current; and rotary converters for direct current. The amperage depends upon the extent of carbon surface. One ampere is generated for each five square inches of carbon surface.

Two views of the experimental apparatus with which the demonstration was made are shown in Figs. 3 and 4. *A A'* are the generating cells; *B*, small gas generator; *C*, small steam boiler; *D*, air tank; *E*, voltmeter; *F*, ammeter; *G G'*, connecting wires or cables; *H*, one of four burners for each cell to warm the electrolyte; and *J J'*, diaphragms composed of alternate layers of iron wire cloth and canvas, to prevent escape of electrolyte and to allow the ingress of free air and the escape of waste gases. The cells, in this instance, are circular, and the carbon electrodes are round hollow rods, about 1½ inch diameter and 10 inches long, making the total carbon surface of each cell about 300 square inches. The carbons are each surrounded by an iron pipe electrode, perforated with holes. The space between the pipe and the carbon is about 3-16-inch all around. The cells were connected in series and developed a current of 1.8 volts and about 45 amperes,

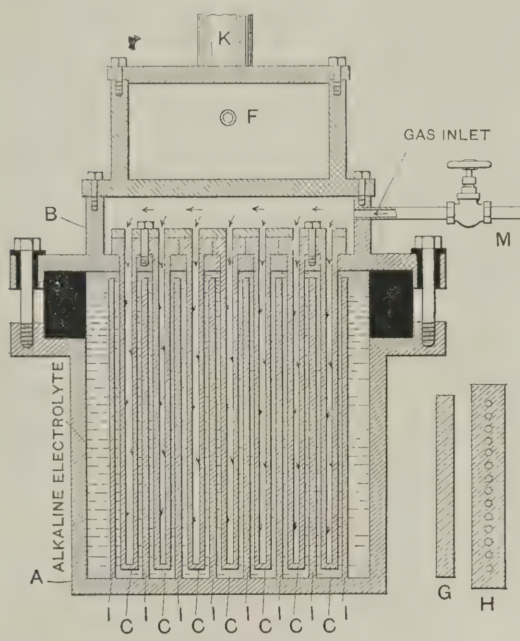


Fig. 1.

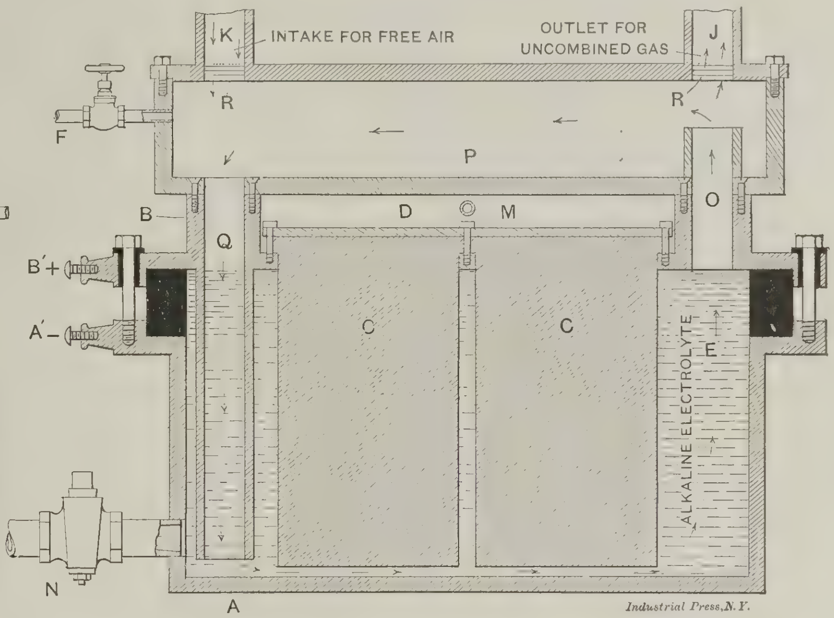


Fig. 2.

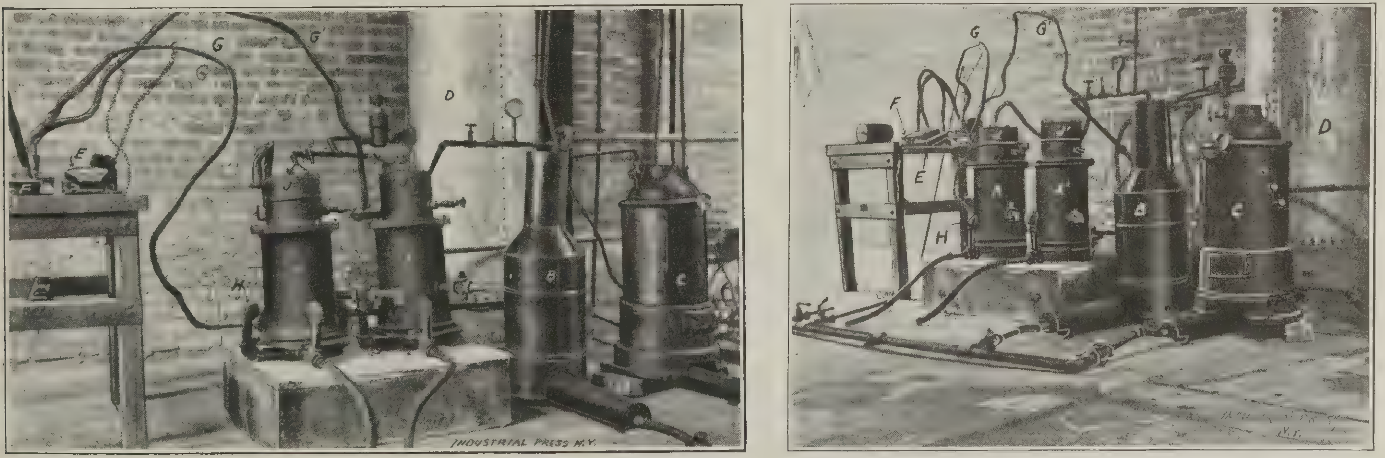
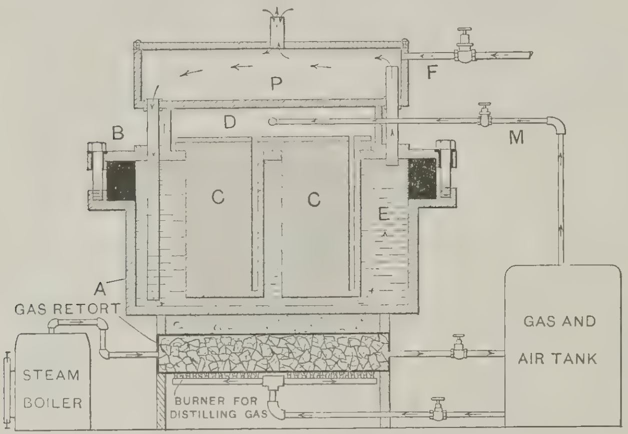


Fig. 3. Fig. 4.

Experimental Electrolytic Apparatus for Producing Electric Power.

operation, to take the place of that evaporated from the electrolyte by the application of external heat. The application of external heat has not yet been described. This is necessary to maintain the electrolyte at the proper temperature, viz.: 392 degrees F. The internal work or waste effort of a cell, even on short circuit, is by no means sufficient to maintain the required temperature. So in the commercial machines the gas retorts will be placed in close connection with the electric generating apparatus in order to use the radiated heat for this equivalent to about 1-10 electrical horse power. The gas connections are made at the bottom from the back. The pipe connections shown in front are for gas to maintain the temperature of the electrolyte, and terminate in four burners for each cell, one being indicated at *H*. In operation a casing covers the body of each cell so as to retain the heat.

It should be understood that the application of external heat in this manner is very wasteful, and that the gas used for the purpose is not charged against the efficiency of the cells, but only that used within them. As already stated, the temperature of the electrolyte is maintained in the commercial machines by the heat radiated from the gas retorts. This is indicated in the diagram, Fig. 5. The consumption of gas per electrical horse power is said to be 5 cubic feet of 650 B. T. U. gas per hour, and the commercial efficiency as being over 45 per cent. of the total heat units in the coal.



Industrial Press,N.Y.

Fig. 5

* * *

WHY THE BUILT-IN MOTORS FAILED.

Editor MACHINERY:

On page 183 of the December number of MACHINERY an article from an exchange is commented upon editorially under the heading, "Hitching the Motor." It seems incredible that the author of this article should be so ignorant of the facts relating to the manufacture of electrical machines as to hold opinions such as are here expressed. Having designed most of the motors which are referred to as having been built in the headstocks of lathes, I have been in a position to watch their operation and would like to tell the real reason why they were superseded by standard motors geared to the lathes.

When the electrical firm referred to took up the matter of motor drive for machine tools, it received no co-operation at all from the tool builders, as the latter absolutely refused to make any change whatever in the design of their tools. In designing the first motors, therefore, it was simply a question of building a motor that would go into a rather limited space with a comparatively large hollow spindle through the center of the armature, to run at a certain speed and give the maximum horse power possible under these conditions. At that time the whole range of speed was obtained by the use of armature resistance and shunt field resistance. These first motors were failures, it must be admitted, but during the eight years that these motors have been in service, not one armature has had to be rewound on account of burn-outs, as stated. Some of them were rewound when the shop voltage was changed from 120 to 250 volts, but these motors served a most valuable purpose in demonstrating the utter impracticability of the use of armature resistance as a means of motor speed control when applied to machine tools. It was not until this same firm introduced the now well-known multiple voltage system into its own shop that a satisfactory method of controlling the speed of these motors was secured. But the real reason for discarding these old motors did not arise until about three years ago, when the introduction of new kinds of tool steel, allowing both higher cutting speeds and cuts of greater cross-section, necessitated the use of motors of larger capacity. As stated before, these motors had been squeezed into a certain given space, and by no possible means could they be made to run at the desired speed and give the torque required to remove the amount of metal that the new tool steels were capable of cutting off. It became a question of abandoning the motors or of using these lathes on a class of work for which they were not intended. The former plan was adopted and motors of ample capacity were attached to these lathes. That these motors should be of standard design was as natural as that a man when using a bolt should use one of standard dimensions; the advantages of using standard parts are as great in one case as in the other.

In order to show that the introduction of motor drive is not being retarded by the fear of "burnt-out" armatures, I would refer to the publishers of most of the large daily newspapers. The necessity of having no breakdowns in the printing press equipment when getting out the regular editions of a large daily is evident. The same firm that built the lathe motors referred to has built most of the newspaper press motors now in use in New York City, and of all of those installed I know of none that has burnt out.

It is true that electric motors often need repairing, but the primary cause of these repairs is almost invariably neglect. Other parts of the machine tool are constantly cleaned and oiled, but the motor is required to run with practically no attention and the dirt that accumulates sooner or later causes trouble. An electric motor, when properly used, is the equal of any other mechanical device now on the market, and, when one considers the amount of abuse it will stand, it surpasses most machines in durability as well as in satisfactory operation.

A. G. WESSLING.

While Mr. Wessling appears to take exceptions to our editorial comment, he substantially supports the dominant idea therein, viz.: "In the present state of the art it is bad design to make an electric motor an integral part of a machine tool." Why? Because such a motor is special; it costs more and cannot be readily replaced, since it is not of standard type. As our correspondent says, it is as natural that motors should be of standard design as that a man using a bolt should use one of standard dimensions.

Of the merits of the case in question, we know nothing, save what was learned casually, and in our comments in the last number did not intentionally, at least, lay the degree of stress upon the burning out of motor armatures that our correspondent seems to think; for it is of secondary importance whether a motor or its armature has to be replaced from this cause or from some other. But as a matter of fact, motors do burn out and must burn out when subjected to great overloads. While our correspondent informs us that the motors referred to did not actually burn out, it is safe to say they would have done so had it been attempted to make them carry the loads that the motors now in use have to carry.

We believe the best practice demands that the motor shall be so located that the whole motor, or any part of it, can be easily replaced by another of standard design, regardless of whether the change is necessary because of the advance in machine shop practice or because of repairs that are required from whatever cause. And we further believe that our correspondent agrees with us in this respect.—Editor.

* * *

The largest lifting machine in the world is said to be the 150-revolving jib crane at Howaldt's Works, Kiel, Germany. The height of the traveler rails from the ground is 154 feet 8 inches, and the length of the jib on which the traveler works is 146 feet 11 inches. A weight of 150 tons is lifted at the rate of 3 feet 3 inches per minute, and one of 15 tons at the rate of 31 feet 2 inches. The speed traveling along the jib is uniform, the rate being of 26 feet 3 inches per minute, and complete rotation of the jib is effected in 10 minutes. The traveler carries two capstans for winding up the steel wire lifting rope which are jointly driven by a 70 horse power alternating current motor. The wire rope is 2.36 inches diameter and is wound eight times around the lifting pulley. The rope for traversing the carriage or traveler has a thickness of 1.81 inches. Both its drum and the two capstan drums are rotated when traversing, but then the two capstan drums turn in opposite directions so that the height of the load is not altered.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The Houille Blanche (white coal) Congress, which recently met in France, brought out some interesting facts regarding the possibilities of developing power from the mountain streams of the Alps and Pyrenees. It is said that the potential power of the waters formed by the melting of snow and ice in these mountain ranges is not less than 10,000,000 horse power, and that 500,000 horse power is already being utilized. France, as is well known, is a country practically destitute of extensive coal beds, and nearly all her coal has to be imported. It is estimated that the saving resulting from the utilization of mountain streams will be not less than $40,000,000 yearly. The economical development of mountain water power as found here is, of course, only made possible by the efficient long distance transmission by the high-tension alternating current.

A Jersey City firm has completed a "battery van" for the United States Government, which in reality is an automobile machine shop designed to go under its own power anywhere that a battery can go, and to be in readiness to make any repairs which may be necessary to the field guns. It has a speed of ten miles an hour and is supplied with two winches and a cable by means of which it can extricate itself from any morass or hole which it might be thrown into while in service. When loaded for the march it will weigh five tons. This will include four thousand pounds of miscellaneous equipment for the batteries which it is following. Six men can be accommodated on the vehicle. This outfit will be assigned to duty with one of the light field batteries and sent on a tour, during which all sorts of demands will be made on it and its conduct under all circumstances will be made the subject of a report.

INSURANCE OF MACHINERY AGAINST ACCIDENTS.

Stahl und Eisen, July 15, 1903, p. 850.

A prospectus has been issued by the *Stuttgarter Mit-und Ruckversicherungs-Aktiengesellschaft*, for the insurance of machinery against damages inflicted as the result of awkwardness or carelessness of the workman as well as from maliciousness. This insurance also proposes to cover such failures of material composing the machinery that may occur after the expiration of the builder's guarantee. Finally such insurance is to include not only the machinery of an establishment but also all that used for transmission purposes such as belting, wire, rope and cable, and, of course, hangers and shafting.

G. L. F.

COMPARATIVE COST OF GAS AND ELECTRIC POWER.

The *Scientific American* recently published the report of a very interesting test which was made in a printing establishment in New York City to determine the comparative cost of power obtained from gas engine and electric motor. The test was made with a 15-horse power gas engine and a 25-horse power electric motor, the average load carried being about 10 horse power. The comparison lasted over a period of two months, during which the gas engine alone was used, and two other months when the electric motor alone was in service. Gas was taken from the city illuminating mains at a cost of $1.05 per 1,000 cubic feet. The engine was run a total of 697 hours and the gas consumed cost $106.68, or an average of 15.3 cents per hour, which is about 1½ cents per horse power hour. Electric current was taken from the Edison mains, and the amount used during the 686 hours of operation of the motor cost $250.30, or an average of 36.5 cents per hour, which is about 3½ cents per horse power hour. Although this test certainly indicates a great advantage of the gas engine over the electric motor, the advocates of the gas engine should not be too sanguinary over the results, since it will be noticed that the motor was operated at but 40 per cent. of its rated capacity and consequently its efficiency was much below that which would have been obtained had it been run at full load.

ELECTRIC LOCOMOTIVES.

The New York Central Railroad has placed a contract with the General Electric Company for thirty electric locomotives to be built by that company in conjunction with the American Locomotive Company of Schenectady. It is said that the electric locomotives are to be of a new design and will weigh 85 tons each, of which 67 tons will be on the drivers. The rated power is 2,200 horse power each, and it is expected that the new locomotives will be capable of hauling a 500-ton train at the rate of 60 miles per hour. It is stated that the officials do not expect that the electric locomotives will show so great a saving of fuel as of maintenance. The fuel consumption of a steam locomotive running 60 miles per hour, is placed at 5 pounds of bituminous coal per horse power hour; with the electric motors, the losses of transmission will make it about 4 pounds at the axles. It is expected that at least 50 miles of each of the New York Central's branches out of New York, and of the New York, New Haven & Hartford Railroad will be operated electrically. The suburban trains will be operated by the multiple-unit system, each car having its own motors, but all under control of one motorman. The longer distance and heavier trains will be drawn by the electric locomotives. With the order for the locomotives, another was placed with the General Electric Company for eight four-stage, vertical Curtis turbo-generators of 7,500 horse power each for the power station.

In commenting on this *The Electrical World and Engineer* says: "It constitutes one of the most important events which have occurred in the history of electric traction since the equipment of the West End Railway, of Boston, in 1888 and 1899. That installation marked the confidence of the largest street railway company in the world at that time in what was then a new motive power. The contracts awarded by the New York Central & Hudson River Railroad, coupled with the adoption of electricity for its New York tunnel by the Pennsylvania Railroad Company, prove in an equally conclusive manner the confidence of steam railroad owners in what has been up to the present a comparatively untried motive power for heavy traffic conditions. The notable feature of the proposed New York Central installation is that electricity has been adopted not only for the tunnel section but as well for the service extending for a radius of about 50 miles on the main line and branches; in other words, for the entire suburban business."

HOW A LOCOMOTIVE WORKED ITS WAY ON THE OHIO RIVER.

Railway and Locomotive Engineering, December, 1903.

The story is told of the firm of Smith & Porter, which later became the well-known H. K. Porter Company. The original firm in 1868 built a locomotive for a small railroad running out of Greenup, Ky. This town is 333 miles below Pittsburg, Pa., on the Ohio River, and at about the time the delivery was to be made none of the towboats appear to have been available, the river being very low owing to a long drought, and other transportation facilities were not to be had. It was, however, decided by Smith & Porter that the engine should be delivered at the specified time. Mr. Smith obtained a suitable flat boat, and placed the machine aboard, and with the help of several men the locomotive was arranged to propel the boat.

The main driving wheels were at the rear, and the side-rod extended forward, as in many of our modern 4-4-2 engines. The front ends of the side-rods were uncoupled and the rods thrown back so that they extended out behind the engine as far as the leading wheels were ahead of the main drivers. The projecting ends of the side-rods were coupled to a temporary crank shaft, arranged for the purpose, and on the ends of this shaft were two paddle-wheels. The main drivers were jacked clear of the rail and the boiler was fired up.

In action the locomotive presented a strange appearance, standing on the deck of a scow, its leading drivers hanging motionless, its main driver slowly turning and its reversed side-rods working a crank shaft which made a pair of dripping paddles revolve, while the engine solemnly puffed its way down stream. This novel locomotive-steamboat made the voyage successfully, and furnishes a good example of what men of enterprise could do to overcome difficulties thirty-five years ago.

THE USE OF RIVETS INSTEAD OF BOLTS IN LOCOMOTIVE CONSTRUCTION.

Railway and Engineering Review, November 14, 1903.

The engine truck of a locomotive generally presents considerable opportunity for improvement both in design and in the matter of construction and repair. It is an axiom that with locomotives the nearer a construction approaches one single piece the more perfect it is. The length of wheel base on the present sizes of power has required the general use of a swinging center casting, which adds to the number of necessary separate parts. But contemplation of either a two or four-wheeled type will bring out in all cases several points wherein the construction could be somewhat simplified. The cradle or transom arrangement is often made in more separate parts than is necessary and in these days of steel castings a superior design of cradle in a particular case could, by the use of this metal, often be obtained. A consideration of the pedestal jaws in connection with the upper framing of the trucks reveals no adequate reason either of service, machinery or wheel changing work standing in the way of making these jaws integral with the frames themselves. Such integral construction would materially diminish the jarring which causes the binder bolts to always be loose. The use of bolts in other places than on these binders is unnecessary—rivets are certainly preferable, for the reaming of holes and machine fitting of the bolts are avoided and there are no nuts to work loose, while there is no occasion for removing such rivets except once a year in the back shop. In fact we know of lines where this plan has been standard for years and their roundhouse work books are not littered with requests to supply missing nuts to engine parts.

INDUCTION MOTOR FOR CRANES.

George L. Hoxie, in Journal Franklin Institute, November, 1903, p. 351.

The induction motor would probably not be used upon cranes and similar classes of work, except for the great desirability of polyphase motors for other work and the inconvenience of maintaining two separate systems of electrical supply. These considerations have, however, led to the use of the induction-crane motor in many cases. The motors, if of squirrel-cage construction, are built with high resistance end rings, and while they give, therefore, a large torque they are not very efficient machines. The efficiency of a direct-current machine is considerably the better through its entire range, and it has a wide range of operation over which its efficiency is quite good. An induction motor, on the other hand, reaches its maximum efficiency very abruptly.

Speed variation in a motor of this sort is accomplished by the use of a special compensator that provides varying impressed pressures. This is not an efficient means of regulation, since the torque of such a motor varies with the square of the impressed pressure. Crane motors with wound secondaries may be made to give a variable speed by the variation of a resistance in series with the secondary. This again is inefficient, though it provides a highly satisfactory torque curve. The motor is not so desirable mechanically since this method of control is considerably more complex. The motor with squirrel-cage secondary is probably the more desirable, on the whole, for this class of work.

RAISING WATER FROM DEEP WELLS BY COMPRESSED AIR.

Extract from Paper read by William H. Maxwell before the Bolton Meeting of the British Association of Waterworks Engineers.

The experiments carried out in the United States by Dr. Pohlé, of Arizona, who for some years past has been engaged in the application and development of the "air lift" system for raising water, oil and other liquids from underground sources, have proved that the main principle upon which the system operates is the following: Air under the necessary pressure, and of suitable volume, is admitted to the bottom of a pipe immersed in the water to be lifted in the manner shown in Fig. 1 of the sketch. By this means alternate bands or columns of air and water are formed in the water-pipe or "rising main," and the air does not, as might perhaps have been anticipated, pass through the mass of water. The result of this is that the aggregate weight of the water in the rising main is insufficient to balance the column of water in the boring, and the pressure of the latter therefore produces an upward movement of the air and water column in the rising main. As the force lifting this column is the head of water at *A* it follows that the height to which the water can be lifted depends upon the depth to which the pipe is immersed below the pumping level of the water in the boring; thus the higher the "lift" required the deeper must be the point at which the air is injected relatively to the normal water level therein, and so the height to which the water has to be raised determines the minimum depth to which the boring must be driven.

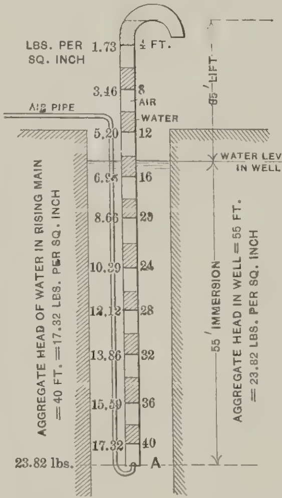
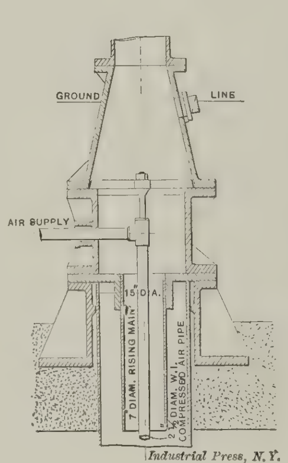


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

With regard to the best proportion between the immersion of the air nozzle and the "lift" of the water, opinions vary, but the author found that in his case the most economical result was obtained when the ratio was 3 (of immersion) to 1 (of lift) at the start, and 2.2 to one at the finish of the test. Under these conditions the efficiency worked out at 36.8 per cent. calculated from the steam diagram, and at 46 per cent. calculated from the compressor diagram, the volumes of air used and water lifted being in the proportion of 2.69 of the former to 1 of the latter.

From the results of his own tests and those of others, the author prepared the following, showing the approximate horse power required to compress one cubic foot of free air to different pressures per square inch:

	Pressure per sq. in.	H. P. per cu. ft. Free Air.
1. Solvay Works, Saaralben	176	0.434
2. Brostowe Estate, near Friedheim	140	0.376
3. Tunbridge Bridge Waterworks..	100	0.201
4. Tunbridge Bridge Waterworks..	80	0.189
5. Tunbridge Bridge Waterworks..	60	0.159
6. Sugar Factory, Glogan.........	45	0.145
7. Yard Works, Zwickan..........	30	0.121

With regard to the quantity of air required to lift a given volume of water to any specified height, the author found the following formula to give results in accordance with his own experience:

$x =$ cubic feet of free air per minute;
$A =$ gallons of water required per minute;
$B =$ "lift" of water in feet;

$$x = \frac{A \times B}{125}$$

From this formula it is, of course, a simple matter to ascertain the quantity of water that can be lifted to any given height by a given quantity of air. The diameter of the air pipe should be such that the velocity of the escaping air shall not exceed 20 feet per second. In a boring 350 feet deep, with the rest level of the water 96 feet below the surface and the pumping level 120 feet from the surface, with a discharge of 32,000 gallons per hour, an air pressure of 91 pounds per square inch was used. The rising main was 7 inches diameter and the air pipe was 2½ inches diameter. See Fig. 2.

EMERY WHEEL PRACTICE IN FOUNDRIES.

Extract from Paper read by Mr. Charles G. Smith before the Pittsburg Foundrymen's Association.

In iron foundry work there can be very little grinding done with economy on heavy castings, unless the iron is hard, in which case the swing frame machine with about 20 x 2½ inch wheel, running at 1,200 revolutions per minute, will grind considerably faster than it can be chipped. The amount of gain in grinding will, of course, depend on the hardness and ductility of the iron. I have seen castings so hard that it took two men one and three quarter hours to chip the gate and fin from one side. In such cases as this two men could have ground this gate and fin with a swing frame machine in a very little over fifteen minutes. But on soft iron the advantage is in favor of the chipping, as in this case the iron spalls before the chisel, and a man with one blow of the hammer can remove considerable of the gate and fin, which gives a great advantage in favor of the chipping. In a great many foundries I have noticed that the grinding on light castings has been done on light machines, using small wheels, and in almost every case the machine has been set without any regard to its stability.

The user will invariably be reimbursed if, in buying an emery grinding machine, he purchases a heavy stand with long bearings and large diameter of spindle, and places it on a concrete foundation. The machine will vibrate less than if it was standing on the floor. The wheels will become out of true less quickly than if they were set so that there may be vibration in the spindle. This will cause considerably less dressing of the wheel, and as it is always necessary to dress the wheel to the lower point when it has become out of true, the user will receive more than reasonable interest on the investment in the foundation in the amount of emery that is saved in truing the wheel. Then it is often the case that wheels too small have been used to accomplish satisfactory results. The largest diameter wheel practicable should always be used for doing any kind of grinding. For instance, a wheel 24 inches in diameter will do more work per dollar invested down to 18 inches in diameter than an 18-inch wheel will do. Another point to be regarded is the belt power furnished to drive the wheel. It is very necessary that the machine have belt capacity to keep the wheels up to speed while they are under duty, as the speed of a wheel when running idle will have no effect on the work if it is not kept up to this speed when it is doing the work. Neglect in the above-mentioned points has caused many to abandon the practice of grinding their castings with emery wheels.

For grinding any castings in a foundry where the man can lift the casting up to the machine it will be found that the most economical and satisfactory results can be obtained by having a heavy machine with 24 x 3-inch wheel driven with 5-inch belt, the wheel speeded at 1,000 revolutions per minute. This gives wheels heavy enough to resist the pressure of the work forced against them, and the power transmitted by the belt will force the wheels to cut instead of shrinking from duty and becoming out of true. This condition invariably occurs where the belt power is insufficient, and the man forcing the work with uneven pressure will bring the wheel to slacken its speed at intervals.

In steel foundry practice the emery wheel has been found to be quite a success, and is as far ahead of any other method that is commonly in use to a large scale on both heavy and light work, as is the case in malleable iron foundries. I have seen a gate ground with an emery wheel on a swing frame grinder by two men in less than 15 minutes. This same gate would have required about two and a half hours to remove on the planer or shaper.

MARINE TURBINES.

Journal of the American Society of Naval Engineers, November, 1903, p. 1241.

The following is an abstract of a report of a board appointed by the Navy Department to investigate the performance of the Steamer *Revolution*, which is equipped with Curtis steam turbines, and was built for experimental purposes. In view of the fact that turbines are now being considered by the Navy Department for use on naval vessels, and are about to be adopted for two Atlantic liners, the report is of timely interest.

The turbines are of the Curtis two-stage, compound, marine type, reversible and condensing. They are two in number, directly connected to the thrust and propeller shafting, each set of turbines driving one screw of about 4 feet 6 inches in diameter and 3 feet 4 inches pitch.

Aside from the ordinary advantages claimed for the steam turbine, the most noticeable feature observed was the almost entire absence of vibration or disturbing noises usually attending the running of fast-moving reciprocating engines, and the slight care and attention needed while in operation. These turbine engines were easily started, stopped and reversed, the time required for each operation being only that necessary for the opening and closing of a set of valves connecting the turbine casings with the main steam pipes. Five seconds was the maximum time consumed for the operation of reversing the motors from full speed ahead to full speed back, with two men handling the gear, one to each turbine. This may, however, be done by one man at a slightly increased expenditure of time. Various runs with corresponding stopping, backing and turning of the ship, were made at different speeds of rotation, the maximum speed of engines being about 650 R. P. M., and the minimum about 250. At full speed ahead the vessel turned readily either to starboard or to port in about thrice her length. Dead in the water, and starting one propeller full speed ahead and the other full speed astern, the vessel turned in her own length. Dead in the water, and with the helm hard to starboard, and then going ahead on the port propeller, the vessel turned readily to port, due to the action of the propeller race upon the rudder. Under these latter conditions it was noticed, however, that the vessel ceased to turn when the wind was well on the port beam.

Running full speed ahead with both screws, and then suddenly reversing the engines, the ship was brought to a standstill in about 32 seconds; the same conditions with one screw, required about 38 seconds. Similar operations were repeated with the vessel running at lower speeds, and about the same amount of time for reversing was required.

In a report on these turbines by Prof. Jas. E. Denton it is stated that at 672 R. P. M. an equivalent power of about 1,800 I. H. P. was developed by both turbines at a steam consumption equal to 18.14 pounds per equivalent I. H. P. This is, however, believed to be excessive, owing to the use of the steam in two stages only. With four-stage turbines the consumption of steam per I. H. P. should be reduced well within the margin of prevailing averages for marine engines.

The clearance spaces between the stationary and running blades on the revolving drum being made extremely small (from .02 inch to .06 inch), the amount of which is ascertained by a small, simple, micrometer attachment, and there being no flexible coupling arranged for between the turbine shaft and the thrust shaft, the bearing of the latter was provided with a handwheel mechanism actuating a yoke, so arranged as to maintain the original clearances by sliding the thrust-block on its sole plate, propeller, shafting and turbine drum all moving together. The wear on the thrust-block being very slight, this adjustment is only rarely resorted to.

The turbine shaft bearings, one at each end of the casing, run in oil, which is continuously circulated and cooled by water coils connected with the oil pump, no water circulation being used direct on the journals; water circulation is however, used in the thrust bearing. The exhaust from each turbine issues from the casing of the upper half of the secondary stage through a 20-inch pipe into the condenser.

The main turbines consist principally of the casings, nozzles and revolving drums containing the bucket wheels and shafts. The steam enters at a pressure of 250 pounds through four steam nozzles, each of which supplies one-fourth of the full power of the turbine, and acts consecutively upon a series of bucket wheels constituting the "first stage," in which the steam expands down from 265 pounds absolute to about 16 pounds absolute. It then flows through four other nozzles, to act upon another set of bucket wheels, which form the "second stage," and there expands from 16 pounds absolute to less than 1 pound absolute, with condenser vacuum of 28 inches, the work done by the steam upon the buckets being thereby nearly equalized.

Reversing is made possible in a very simple manner by placing vanes on the outer rim pointing oppositely to the ahead buckets, all enclosed in the casing of the secondary stage. A separate steam pipe leads to this part of the casing and the steam is admitted by a separate valve.

The general ease with which the machines in question are cared for and handled is undoubtedly due to the great simplicity of the mechanism when compared with the reciprocating engine. As an engine it requires but little previous "warming up;" no cylinder drains to be opened nor any general filling up of oil boxes, sight feeds and wick cups, the turning on or the shutting off of the main steam supply being the principal and almost the only operation remaining. It might be here incidentally mentioned that the above points are not features peculiar only to the turbines of which this report treats, but hold in common for steam turbine machinery of the various designs and makes. The space occupied, judged in the light of a casual observation, is no less, but rather more, than that required by engines of the torpedo-boat class; but, as there is not the same amount of overhauling necessary, the extra space can well be spared. The weights of the turbines proper in this case are alleged to be 8¾ pounds per equivalent I. H. P., and are thus less than those of torpedo-boat engines, which run about 11½ pounds per I. H. P. The attention required and the amount of oil used are extremely small, owing to the entire absence of any internal or external oiling except the main bearings, which are automatically oiled. No frequent adjustments are required, as there are no rubbing surfaces, which may best be illustrated by the fact that the turbines in question have never been apart since first put up, covering a period equal to one and one-half years.

The points in conjecture with regard to these machines being their efficiency and their capacity to compete in economy with the best marine engines, should be ascertained by more accurate tests, both on land and on board ship, where this is possible.

Additional fore-and-aft space will be required for any efficient installation of turbines as compared with the reciprocating engine installation, and particularly will this be found in torpedo boats. This fact should be well recognized and be given due consideration, so that all parts of the mechanism, but particularly the condenser and other auxiliaries, may be installed in such manner as will permit frequent and necessary overhauling from the engine room.

As the turbine is more dependent upon a high vacuum than is the case with a reciprocating engine, it is essential that the main condensers and main air pumps must be favorably placed in the ship for ready examination and overhauling.

RESPONSIBILITIES OF INVENTORS.

E. P. Thompson in Stevens Indicator, October, 1903, p. 411.

How unfortunate for inventors, manufacturers, and other owners of patent rights, including corporations of enormous capital, that the value of a patent does not necessarily depend alone upon the value of an invention, nor upon any power that the inventor or other owner is supposed to possess. The inventor might be literary, a great scientist, an engineer, and an electrical expert, and might be able to explain an invention that he had made better than anybody else; and yet, if the description were not according to form, and especially if the solicitor should not have sufficient skill to word the claims to properly protect the invention, the invention would practically be given to the public.

My object is to show the principle underlying the difference between a properly broad claim and a narrow one, so that an inventor, in writing a description of the invention for his solicitor, may define his invention after the manner of a sufficiently broad claim. Electrical inventors are, in the present age, highly educated and should be perfectly competent to define their invention from a broad standpoint, and then the solicitor can improve the wording and form, and supplement applicant's claims by subordinate and perhaps by a slightly broader claim. I do not propose to take your valuable space by a lecture on the general principles of claims, but to show this one point by examples, by studying which, your readers will be competent to see that their claims are about what they should be.

Their inclination is to leave all to the solicitor, but this is not advisable, because however expert he is he is not infallible. As the whole value of the patent depends upon the scope of the claim, and as the inventor is the one who is best acquainted with the device and with the department of art to which the invention belongs, he must not leave the matter entirely to the solicitor; and the solicitor who refuses aid and suggestions from his client is more concerned with his own conceit than with his client's interests. The attorney is superior on all formal matters, but the client is superior on the merits. The solicitor should acquire as much as possible of the technical points, and the client should have a fundamental knowledge of the nature of claims.

A few examples will suffice to explain.

A few years ago there was an inventor who was the first to invent a new rheostat element adapted to be varied. His claim on this feature reads:

"The combination, with a box or case, of a pile of thin sheet-metal resistance plates therein, and a screw for regulating the pressure upon said plates, substantially as specified."

An inventor should not only make the invention in one form, but think of several ways of carrying out the device, and then formulate a definition to cover all the devices. All such devices could, I think, be covered by a claim reading:

"A variable electric resistance, consisting of the combination of a pile of electrical resistance plates, and means for varying the pressure upon said plates."

It is held that it would be easy for pirates to get around the patent claim, but difficult to avoid infringement of the proposed substitute claim, which may be possible of still further improvement.

Another case is that of a photometer for measuring mean spherical candle-power. The method consists in revolving two mirrors about an axis passing through the source of light under such conditions that the light from the source is reflected in different successive angles of a single plane upon the screen of a photometer, and also transmitted in this reflected passage according to a certain simple harmonic law. For our purpose, it is immaterial to explain what law this is, as too much space would be necessary. The broadest combination claim reads:

"In an apparatus for measuring the mean spherical luminous intensity of a source of light, the combination of two revolving mirrors, and means for varying the intensity transmitted to the photometer according to a simple harmonic law."

Why limit the protection to mirrors, leaving a loophole for another inventor to use refraction? Why confine the scope to a simple harmonic law, when the inventors are entitled to broad protection upon any arrangement of reflecting or refracting devices for securing the same result?

The claim could have been as broad as the following:

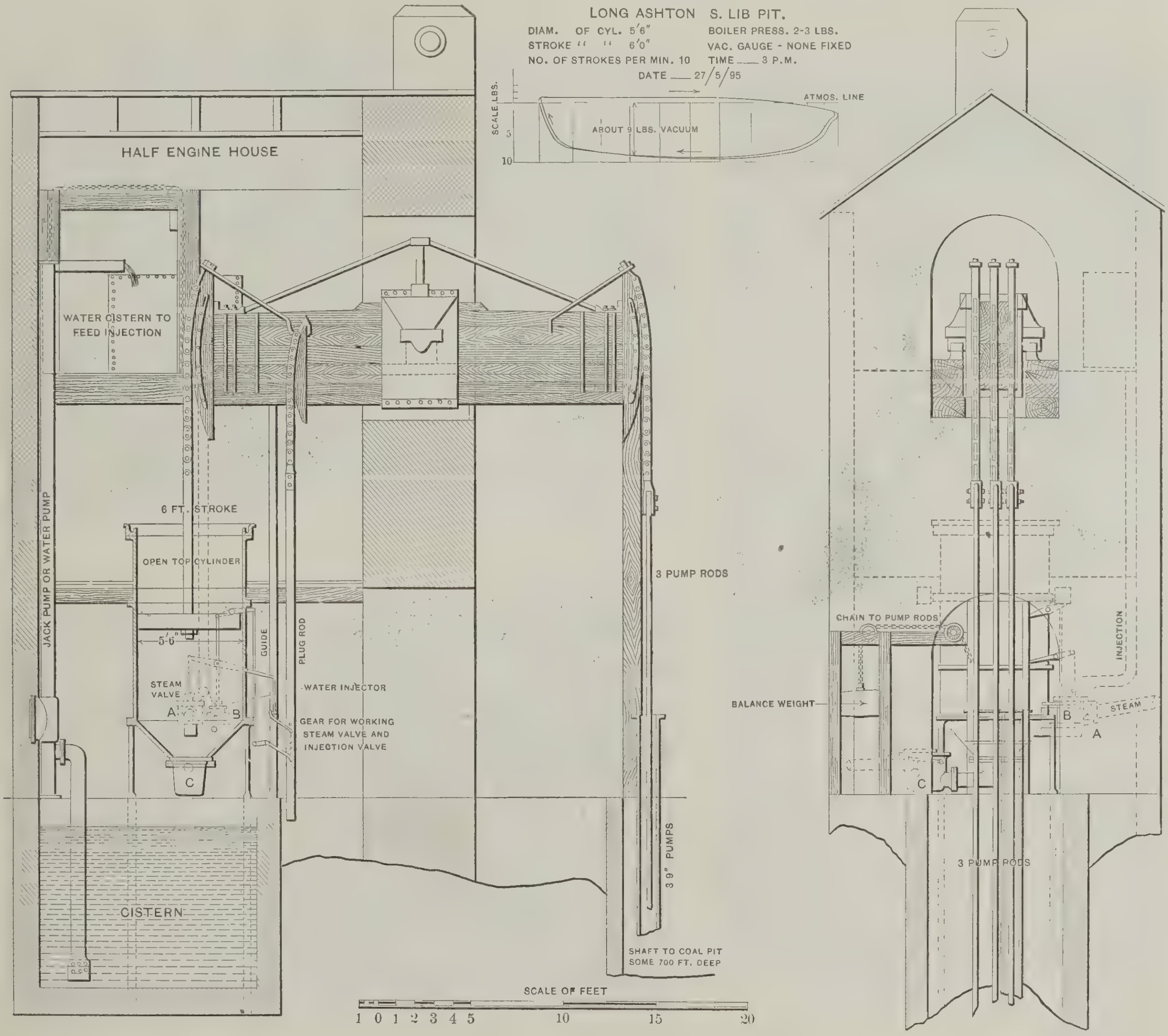
"In an apparatus for measuring the mean spherical luminous intensity of a source of light, the combination of a photometer, and revolvable devices so disposed as to illuminate said photometer proportionally to the mean spherical candle-power of said source."

This claim would have protected the invention, whether on the principle of a simple harmonic law, or some other law. The patent claim is also faulty in the narrow term "two revolving mirrors." Other means could easily be invented, and infringement avoided. If the scope is not defined by a proper wording of the claim, the patent is about as valuable as a house standing on a lot having a defective title.

NEWCOMEN ENGINE AT THE ASHTON VALE IRON WORKS*

From Paper read by Mr. Henry Davey before the Institute of Mechanical Engineers, October 16, 1903.

The earliest instance of a pumping engine for colliery purposes, which had come under the writer's notice, was that of the Newcomen engine at the South Liberty Colliery of the Ashton Vale Iron Company, near Bristol. As is well known, Thomas Newcomen, of Devonshire, invented, in 1705, the first successful cylinder and piston engines, and this example is considered one of the early large engines built by him, possibly about the year 1746-50.† The drawing, Figs. 1 and 2, shows the general arrangement of the engine, and has been prepared from a sketch the writer had made in September, 1895, when he had occasion to take some particulars on the spot for illustrating this old relic. The drawing, together with three photographs, Figs, 3, 4 and 5, will convey to readers the rude though successful working structure of Newcomen's age, with its trussed oak beam with circular ends and open-topped cylinder. The cylinder was 5 feet 6 inches in diameter, and had clearance enough to allow of working 8 foot stroke if required (the cylinder is 10 feet long). The piston was packed with rope ends and loaded with pig iron to help balance the indoor stroke, and was worked with a covering of water on the top, so that if the packing was not quite tight, water only passed through and helped to maintain the vacuum. The valves fitted to the cylinders consisted of a circular lift steam-valve for admission of steam (marked *A* in drawing), a slide-valve, *B*, for admitting injection water to condense the steam for forming the vacuum, and a flap-valve, *C*, kept closed by a weighted lever) for the escape of the condensed water. The Newcomen engine was utterly dependent on manually-worked valves, until that eminent youth Humphrey Potter devised self-acting catches, whereby the working beam was made to supplement the opening and closing of the valve.‡ This led to the introduction of the plug-frame fitted with catches to act on the valve levers—first put on a Newcomen engine by Henry Beighton in 1718. The engine was at first supplied with steam from a haystack boiler, but was latterly supplied with steam from the boilers working the winding engine, which was passed through a reducing valve into a receiver down to a pressure of 2½ pounds to the square inch, at which pressure it entered the cylinder. The beam was built of oak timber, trussed with rods 24 feet long and 4 feet deep, and had V-shaped gudgeons of cast-iron (bolted to the beam



Figs. 1 and 2. From a Sketch of an Old Newcomen Engine.

Industrial Press, N.Y.

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* Compiled by the writer from particulars taken by him from the engine itself at the South Liberty Colliery in 1895, at which date the engine was in regular work. It has since been dismantled. There is at South Kensington a photograph of this engine, taken many years ago, when it was in a more perfect condition than it was in 1895.

† Mr. W. G. Norris writes that he has little doubt that the castings for this engine were made at Coalbrookdale, about the year 1760, or perhaps a few years earlier; no castings so large could have been obtained much earlier than this date.

‡ Mr. Davey discredits the story of the Humphrey-Potter invention. The contrivance said to have been invented by Potter is described in the following: "In some engines there is a catch held by a chain fixed to the great beam, and this catch holds the eff from falling back and opening the cold-water cock, till the rising of the beam pulls the catch up by the chain and then the eff falls." The story probably arose from calling cock-buoy cock-boy, a buoy being used for opening and closing the cocks.

in the form of a collar) rocking in cast-iron gudgeon-blocks. Its weight with the gudgeons, trusses, etc., was about 5 tons. The engine made from ten to eleven motor strokes per minute.

The pumps, which were three in number, were bucket lifts, and 9¾ inches in diameter, and were worked from the end of the beam by chains secured to the beam and passing over the wooden arcs at ends of beam (as shown on the drawing) and thence down to the rods of pumps, which were of wood bolted together, with side straps. The pumps were in three lifts, and delivered one into the other from the bottom of the shaft, which was 750 feet deep. There was a jack-pump attached to the engine, which lifted water into a cistern at the level of the beam floor, to supply the injection water to the cylinder. It may, perhaps, be interesting to describe its mode of action. A vacuum was formed on the under side of the piston by the admission of steam, which was then condensed by the admission of the injection water, and the top of cylinder being open to the atmosphere, the atmospheric pressure exerted itself on top of piston, causing it to descend with an energy due to the perfection of the vacuum formed, and so producing the indoor stroke which lifted the pump rods at the other end of the beam, thereby actuating the buckets of pumps and lifting the water from the bottom of the shaft. The outdoor, or descending stroke, of the pumps was made chiefly by the weights of the rods, etc., and thus the double stroke was completed.

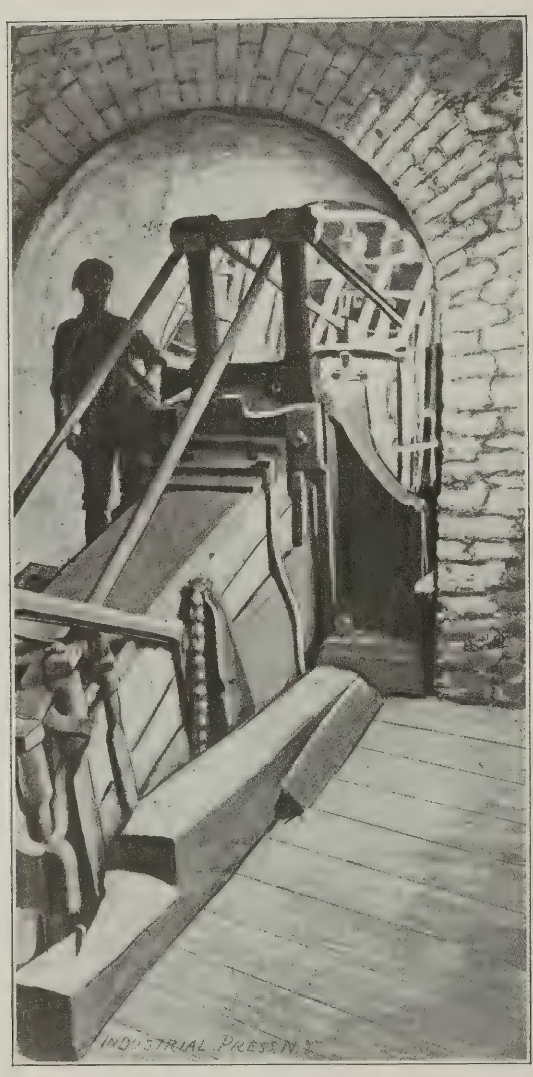

Fig. 3. View of Old Walking Beam.

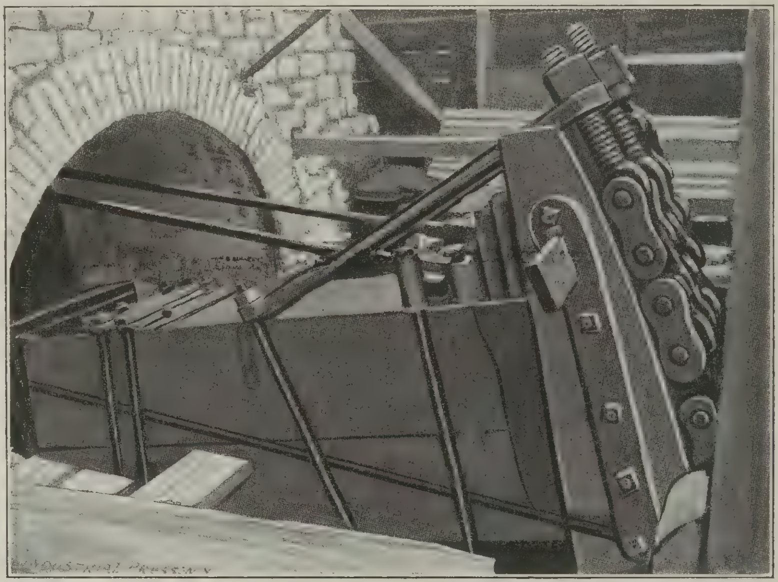

Fig. 4. Point of Attachment of Chains to Walking Beam.

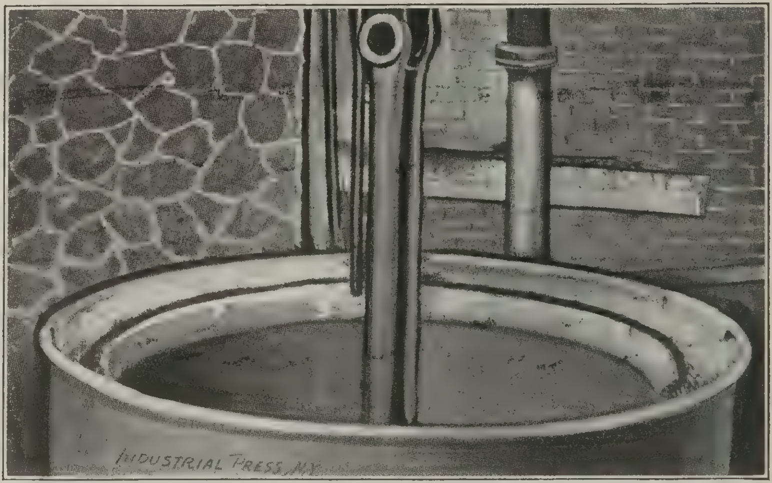

Fig. 5. View of the Open-top Atmospheric Cylinder.

No indicator diagrams had ever been taken from the cylinder until the writer took some in 1895, for which purpose the cylinder had to be drilled and indicator connections and gear fitted. The diagram, shown with Figs. 1 and 2, represents the indicator cards showing the amount of vacuum to be between 9 pounds and 10 pounds. This diagram, at a speed of 10 strokes per minute, gives about 52 horse power. The old man, seen in Fig. 3, near the gudgeon-blocks, worked the engine up to the time of its being dismounted in 1900, and had driven it since he was a boy; his father and grandfather had worked the engine before him.

* * *

The property of calcium carbide of rapidly developing acetylene gas, when brought in contact with water, has led to its use as a means for raising and sinking submarine boats. The boat is supplied with an ordinary gas generator and a water tank, whose contents serve as ballast. The upper part of the tank is connected with the gas reservoir of the generator by a pipe so that gas can escape into the tank. The tank and the generator have pipes at the bottom opening into the sea water. The upper parts have vertical pipes for the escape of the gas. If the reservoirs are filled with water, the boat sinks.

After the introduction of a carbide cartridge into the gas generator gas is formed at once, which forces the water through the lower pipe into the sea. After opening the cock in the connecting pipe, the gas enters the tank and fills it by forcing out the water. The boat now rises to the surface, remaining there until the gas is allowed to escape from both reservoirs, which causes them to be again filled by sea water. If the boat has sunk deeper than desired, the introduction of a sufficiently large carbide cartridge into the generator will make the boat rise to the proper level. The apparatus is quite simple and works reliably, doing away with air and water pumps.

TOOL MAKING.—2.

REAMERS (Continued).

E. R. MARKHAM.

It is the intention of the writer to explain in a brief yet thorough manner the methods usually employed when making the various tools used in machine shop work; and he trusts that the skilled mechanic who has at his tongue's end the various methods here explained will patiently consider that it is for the many who have not been so fortunate as he that these articles are written. An article that would tell the skillful workman many things he does not already know would be of little benefit to those who are anxious to get the fundamental principles on which to build an experience that will be of value to them. Now a certain principle that may be fully explained under the heading of reamers may apply to similar operations as applied to other tools; but in cases of this kind the explanation will not be repeated, as under such circumstances the series would have no ending. For this reason we request that the reader who is anxious to learn as much as possible will try to impress on his mind the methods here given and apply them to other articles where the description is omitted.

In our last article we stated that it was formerly considered necessary to give *fluted* reamers an uneven number of cutting teeth to avoid chattering when the tool was in use, but that experience had proved that a reamer having an even number of teeth *unevenly* spaced worked as well and was easier to make. It could be ground to size at less expense, because the teeth were directly opposite each other, which made it possible to gage the size by means of a micrometer without removing the work from the cutters of the grinding machine—the unevenness of spacing being between adjoining teeth.

In cutting the teeth an uneven distance apart we move the index pin a different number of holes for each adjoining pair of teeth. The variation from even spacing, as before stated, should be from 2 to 4 degrees. To illustrate the method referred to of getting the irregularity we will take as an example a reamer to be cut with ten teeth. Supposing the milling machine to be used has an index head which requires 40 turns of the index pin lever for one revolution of the spindle. Then with the index pin set to the circle on the dial containing 18 holes we find that in making one revolution of the index-head spindle—which is, of course, equivalent to one revolution of the reamer being cut—the index pin must pass 40 × 18 holes = 720. As there are 360 degrees in every circle we divide 720 by 360 = 2. It is apparent that a movement of two holes, with the index pin in the 18 row of holes, moves the work being operated on through one degree of space. If we were to mill 10 equally spaced grooves in the reamer then we would make a movement of four revolutions of the index pin each time, which would give us a movement of 4 × 18 = 72 holes or 36 degrees, which is exactly one-tenth of a circle. As we have the teeth unevenly spaced we first cut a tooth, then revolve on index head one-half revolution by revolving the index pin 20 revolutions and cut the second tooth—as shown in Fig. 1, directly opposite the first. We next move the index pin 64 holes and cut the next tooth; then revolve the head one-half revolution and cut the opposite groove. As a movement of 72 holes would give an equal distance between cutting edges it is apparent that moving 64 holes would cause an irregularity of spacing of 8 holes, and as each hole represents ½ degree the irregularity would amount to 4 degrees. Our next move will be 68 holes, which will require 3 entire revolutions of the index pin and an additional movement of 14 holes. As our previous move was 64 holes and this is 68, we have a variation of 4 holes, or 2 degrees. We next move 76 holes, then 80 holes for the last groove, and we find it would require a movement of 72 holes to carry us to our first groove. Now if we add the different number of holes moved to cut the various grooves we find we have moved the sum of 64 68, 76, 80 and 72 holes, which is 360 holes or 180 degrees, which is one-half circle. And as we cut the two teeth opposite each other every time we made an irregular spacing we would pass through an entire revolution of a circle—360 degrees or 720 holes.

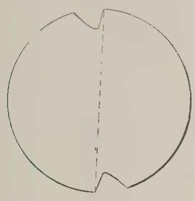
Fig. 1.

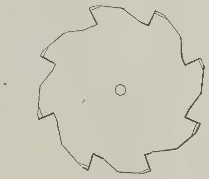
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Fig. 9.

Thickness of Land. When cutting the flutes of reamers with the form of reamer cutter mentioned in Article 1 the depth should be so gaged that the land will be about 1-5 the average distance from one cutting edge to the next. This will necessitate cutting some of the grooves deeper than others, as the irregularity of spacing causes an unequal distance between adjoining cutting edges. If the flutes are cut deeper than mentioned the lands will be thin and weak, and will spring when in use; and if they spring out into the work being cut they will stick and break. If they are cut much shallower they do not form a sufficiently large receptacle for chips.

Hardening Reamers. Extreme care should be exercised when hardening reamers, to avoid springing. Tools of this character should *never be overheated,* as it leaves the cutting edges brittle and unfit for use. If the necessary facilities are at hand the best results will be obtained if the reamer is hardened by the process known as "pack hardening;" but if this is not feasible we must heat very carefully and harden in the usual manner. With a muffle furnace at hand a uniform heat may be obtained very easily; but if obliged to use a blacksmith's forge the reamer should be placed in a piece of gas pipe, or tube, to prevent the fire from coming in contact with it. This method also prevents the air from the blast from striking the edges and causing them to crack. It is necessary to frequently turn the pieces that are being heated.

When uniformly heated to the desired temperature the reamer may be taken and plunged into a bath of water, or brine, from which the chill has been removed. It should be in as nearly a vertical position as possible, to avoid springing; when pieces are dipped at an angle the bath acts unequally on the opposite sides and consequently these contract unequally, which causes them to crook. The pieces should also be worked up and down in the bath somewhat, as this prevents the steam generated by the contact of the red-hot steel and water from forming a cushion around the reamer and keeping the water from it. If the reamer is larger than ⅞ inch diameter it should be held over the fire immediately after being taken from the bath, to remove strains set up by the hardening. Another method consists in removing the reamer from the water bath when it stops "singing" and immediately plunging in a bath of oil, allowing it to stay there until it is reduced to the temperature of the oil. The temper should be drawn to a straw color.

Should the reamer spring when hardening it may be straightened by applying pressure to the convex side after heating, the reamer being held between the centers of the lathe. This method of straightening hardened work will be more fully explained in the article on counterbores.

Grinding Reamers. When articles having centers in the ends are hardened, scale and dirt collect in the centers, and in order to get satisfactory results when grinding it is necessary to clean the center holes. This may be done by grinding a three-cornered file to a point at the end and using it as a scraper. Should the article be ground while dirt and scale are in the center holes it would in all probability run out so badly that it would not be possible to "clean" it when grinding. But should there be plenty of stock to allow of truing, some of the dirt might become loosened when the piece was being ground, and either change its location or fall out, and in either case it would cause the piece to again run out of true.

When possible it is advisable to grind work in a machine having two *dead* centers. All universal grinders are made this way. When a piece of work is ground in a lathe or other machine having one *live* center, there is a liability of the center not running true, or of the spindle which contains the center being out of round, in which case it will duplicate its shape on the article being ground. Then again the irregular draw of the belt does not affect the shape of the piece when the spindle is *not revolving*.

Be sure the centers of the grinding machine are in good shape, and to gage. The reamer should first be ground to run true; and to accomplish this place the dog on the cutting end of the reamer and grind the shank to size, then place the dog on the shank end and grind the body to within .001 or .002 inch of finish size. Small reamers are given the less amount and large reamers the greater. Having ground the body to the dimension mentioned, we proceed to back off the cutting edges for clearance; and to make the clearance as straight as possible we use as large an emery as can be used without striking the cutting edge of the tooth next to the one being ground. In order to get the correct clearance we rest the face of the tooth being ground on the guide finger, which can be adjusted to give any desired amount of clearance. Fig. 2 shows an end view of a fluted reamer being ground for clearance. *A* represents the emery wheel, which should be run in the direction of the arrow, so that the tooth of the reamer may be pressed down on the finger *B*. Should it be run in the opposite direction it would tend to draw the tooth up from the finger and cut away the cutting edge—thereby spoiling the reamer. However, when using a dry grinder—that is, one where water is not run on the emery wheel—the danger of heating the tooth and drawing the temper is greater when the wheel is run in the direction shown in Fig. 2; but if the face of the wheel is kept free from glaze, and ordinary care is exercised, there is little danger of starting the temper, provided we use a free cutting wheel that is not too fine. To give the tooth the proper clearance the finger is adjusted to bring the cutting edge below the line of centers, the dotted line denoting this. Do not attempt to remove too great an amount of stock at a cut; rather, take more cuts, going way around the reamer each time the adjustment is altered.

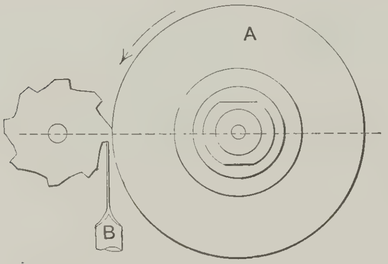

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Fig. 2.

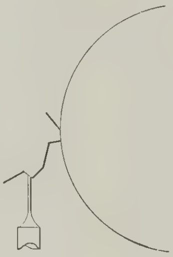


Fig. 3.

When grinding reamers for clearance it is absolutely necessary to rest the face of the *tooth being ground* on the finger, otherwise the teeth, being irregularly spaced, would not be ground with an equal amount of clearance. Neither would the cutting edges be the same distance from the center were we to rest on the tooth next to the one being ground, as shown in Fig. 3, as is done sometimes when work is being ground that has evenly-spaced cutting teeth. But in any case it is not advisable to rest on any tooth face but the one being operated on.

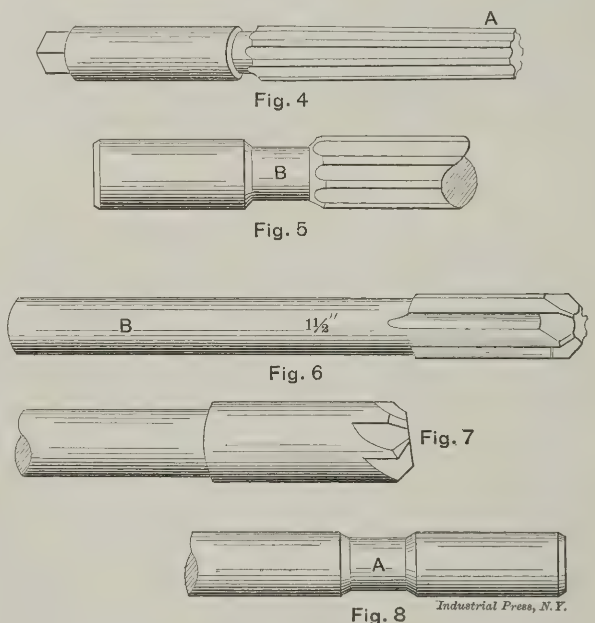
To insure fluted reamers maintaining their size when in use the clearance should not be ground to the edge of the teeth, as though it were a milling machine cutter; it should be ground to within .01 or .015 inch of the edge, the amount left depending on the size of the reamer. However, if the reamer be very small it is best not to leave more than one-half the first amount mentioned. To bring the clearance to the edge use an oil stone. It is necessary during this operation to stone to the desired size, which may appear to some a slow and costly way, but if a free cutting stone of medium grade is used for removing the stock, it can be accomplished in short order. In order to get an edge that will produce a smooth hole and stand up, use a fine stone for finishing. Do not, under any circumstance, use the stone dry; neither should it be allowed to glaze. The face of the stone being used should be flat, and free from indentation of any sort if satisfactory results are desired. It may be trued up by grinding on a wet grinder.

Do not give the cutting edges of a fluted reamer any more clearance than is necessary to insure its cutting freely. Too much clearance makes a weak edge, which chatters and soon loses its size.

As fluted reamers differ from rose reamers in that the latter cut on the end, it is necessary to taper them somewhat for a distance from the end in order that they may enter the hole to be reamed. This taper is represented at *A* in Fig. 4. As this form of reamer is not intended for removing much stock the taper should be very slight. This portion is, of course, given clearance the same as the balance of the tooth. When stoning the point where the taper and straight part of tooth join, it should be slightly rounded so as to avoid making a mark in the hole being reamed. This should be very slight, yet enough to break the abrupt end of taper and commencement of the straight portions.

While the instructions just given relate to fluted hand reamers, they apply in principle to fluted chucking reamers. The shanks of the latter, however, may be turned to size before hardening without leaving any allowance for grinding unless they are to be held in chucks of some form of holder. In this case they must be left somewhat large, and be finished to size after hardening, to insure their running true when in use.

When fluted reamers are intended for use in the lathe, and are not to be held in a chuck or any style of reamer holder, they are ordinarily made of the form illustrated in Fig. 4. When they are to be held in a holder as when used in a drill press, screw machine or chucking machine, they are made as shown in Fig. 5. In this style of reamer the portion to be placed in the holder should be ground after the reamer is hardened, to insure its running true; and on this account it should be left .010 to .015 inch larger than finish size. The portion necked below the body and shank, which is marked *B*, may be turned to the size called for on the drawing, and finished. The size of the reamer and any distinguishing marks needed may be stamped on this portion, care being exercised, however, not to spring it by this operation.



Figs. 4 to 8. Fluted and Rose Reamers

Reamers that are held rigidly at the end of shank are, for several reasons, liable to cut holes somewhat larger than their own size. For this reason in many shops all reamers used for chucking purposes are made somewhat smaller than the hole to be reamed for finish, and after running these through the hole, "standard" hand reamers are used to produce the finished hole. Many mechanics claim this precaution is unnecessary, contending that any hole which must be of exact size should be left a trifle small and lapped to size. However, as this is a matter of opinion, and must be determined by circumstances, we will not discuss it, but will give the required amount to leave for the hand reamer, if it is thought necessary to finish the hole with this rather than with the chucking reamer. The amount of stock to leave for the hand fluted reamer varies according to the custom and notions in the individual shop, and the tool maker must be governed by the ideas of those in whose employ he may happen to be. But in order that he may have some idea of the amount necessary we will give the custom in a shop using many reamers on all classes of work: For reamers under ½ inch .002 inch is allowed; between ½ and ¾ inch .003 inch; between ¾ and 1 inch .004 inch; between 1 and 2 inches .006 inch. For reamers larger than 2 inches diameter .008 inch is allowed. As these amounts are not considered proper to produce good results in other shops no exact amounts can be stated arbitrarily, but the conditions existing in each shop, the stock to be cut, etc., must determine how much stock the finish-reamer must remove. However, if we are to take out only the small amounts mentioned for the small reamers, the holes will have to be smooth and in good condition before we ream them, or we shall not be able to correct any imperfections that may have existed.

Rose Reamers.

The form of reamer known as "rose reamer," Fig. 6, has its cutting edges on the end, as shown. The grooves which are cut the entire length of the body serve the purpose of reducing the amount of bearing surface in the reamed hole, and also furnish ways to conduct the oil or other lubricant to the cutting portion. Rose reamers were formerly made without the grooves, as shown in Fig. 7; the body of the reamer was solid, with the exception of the cuts made to form the teeth at the end, and for this reason they caused a vast amount of annoyance by "wringing up" the stock in the hole of the piece being reamed. This trouble has been done away with, however, by the reduction of frictional bearing effected by cutting the grooves.

Reamers of this character will cut a hole that is nearer parallel than is a fluted reamer, when there are blowholes or other irregularities of surface in the walls of the hole being reamed.

In some shops it is customary to use a rose reamer a few thousandths of an inch smaller than finish size, before using a fluted reamer, thus insuring the proper amount of stock to remove with the fluted reamer, which does not work well if it has too much stock to remove when cutting.

Small rose reamers for use in an emergency are oftentimes made from a piece of drill rod of the right size. This is cut to the proper length, placed in a chuck on the lathe and the end is beveled the proper amount for the cutting lips. The grooves may be filed with a three-cornered or round-edge file, the cutting edges backed off, and it is then ready for hardening. It is advisable to harden up for a distance as great as the reamer is to enter the work, or it will "rough up" when in use. If the reamer is to be used in reaming *long* holes it is advisable to neck down a short distance back from the cutting edges as shown at *A* in Fig. 8, and have the hardening end in this necking, as a peculiarity of drill rod is that it apparently expands at the point where the hardening stops, and if it stops in the smaller part it will not bind in the reamed hole. These remarks of course apply to reamers that are not to be ground to size after hardening.

When making the ordinary form of rose chucking reamer shown in Fig. 6 we select stock enough larger than finish size to allow the removal of all the decarbonized portion. After turning a roughing chip all over the piece, the shank *B* may be turned to finish size, unless the reamer when in use is to be held in a chuck or other holder, in which case there should be sufficient stock left to true by grinding after the reamer is hardened. When rose reamers are to be used for reaming holes that must be exact as to size they must be ground to correct size after they are hardened. To prevent them from binding in the hole being reamed it is advisable to grind them a trifle tapering, making the body 1-4000 inch smaller on the end next to the shank. A greater amount of taper would not do, as the reamer would not be sufficiently supported in the hole when in use, and might run.

When rose reamers are made from drill rod and are *not* to be ground after hardening, the necessary clearance to give the cutting edges may be obtained by filing. Make sure that the clearance goes to the edge, as otherwise the tooth will not cut. Care must be exercised also not to file too much. This would reduce the length of the tooth, as one tooth would be shorter than the others and would not do its share of work. Cutting tools having more than one cutting edge should be constructed so that each edge does its proportional amount of work. If reamers are ground to size the cutting edges should be given clearance by grinding also, thus insuring teeth whose lengths are exactly alike. The bevel given the corner produces a point where it meets the straight part of the body, Fig. 6, and this point it would produce a scratch in the hole being reamed; so this sharp corner must be removed by means of an oilstone, to insure smooth walls in the hole.

Large rose reamers, and those to be used in reaming brass and the various other alloys of copper, should have the lands of about the width of fluted reamers. The bearing surface of the lands must also be reduced, which may be accomplished by filing, commencing at the heel of the land and filing a clearance to within a short distance of the opposite edge. The distance left untouched varies with the character of the work to be reamed, but for most purposes 1-32 inch would be about right. The neatest method of giving the land the clearance mentioned, however, would be by grinding, leaving it as shown in Fig. 9. The amount of clearance in this sketch is exaggerated, so as to illustrate the principle. It need be only sufficient to insure the reduction of frictional resistance, which is very pronounced when reaming the softer metals.

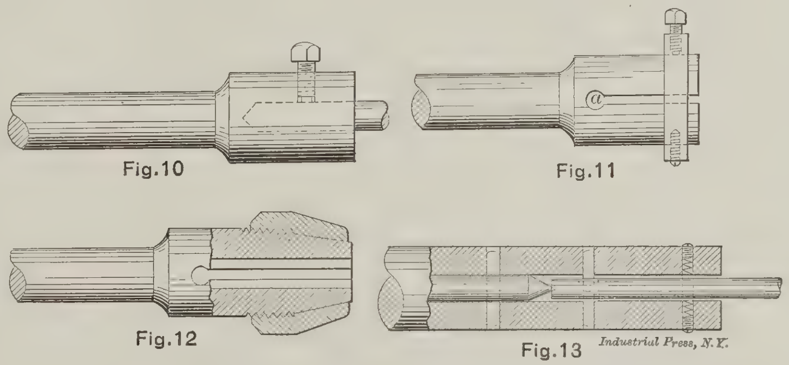


Fig.10
Fig.11
Fig.12
Fig.13
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Figs. 10 to 13. Forms of Reamer Holders.

Reamer Holders. When reamers are operated by hand they are held in a reamer or tap wrench. When used in an engine lathe they are sometimes held with a wrench, and at other times, placed in a drill chuck. When used in a drill press they are held either in a chuck or a collet having a hole in the end the exact size of the reamer shank. The shank must fit exactly in the hole, and the hole must be true with the collet. We might carry this line of reasoning still further and say that the spindle of the press must be true, but this is outside the intended scope of these articles.

When reamers are used in the screw machine, or chucking machine, they are held in reamer holders. Of these there are several styles, the simplest of which is shown in Fig. 10. It is ordinarily made from machine steel, one end of which is turned to fit the hole in the turret while the opposite end is turned to finish size. A hole is bored in the end to receive the reamer shank, the reamer being held in place by a setscrew. When fitting tools of this character to holes in the turret it is advisable to test the holes for size. If there is any variation, fit to the proper hole, then mark the holder to correspond with the hole it is fitted to.

A second form is shown in Figs. 11 and 12. In this holder the reamer is held by closing the sides of the holder onto the shank. These jaws are closed in Fig. 11 by means of the collar and setscrew, while in Fig. 12 the ends of the jaws are tapered and a nut with a tapered hole forces the jaws together. A third form is shown in Fig. 13 and is generally termed a "floating" reamer holder, because the reamer is not held rigidly in position. The object attained in using a holder of this form is that, should the turret holes not line perfectly with the head spindle, the reamer is free to adjust itself to proper alignment, thus doing away with the tendency to ream a hole somewhat larger than its own size at the outer end of the hole.

When making the holder shown in Fig. 10, a piece of machine steel somewhat larger than finish size is used. After turning a roughing chip over the piece one end is fitted into the hole in the screw machine turret, the other end turned to size and the large end run in the back rest of the lathe, while the opposite end is strapped back against the live center. The hole in the end that receives the reamer is drilled and bored to size. Previous to strapping the work against the center, test the center to make sure that it runs true. If it does not, it should be trued before proceeding, for the hole bored in the end would not be true if the center were not true. Care must be taken when fastening the piece back against the center not to draw it to one side by careless methods of strapping; this would also cause the hole to be bored out of true.

If the hole to be made in the end that is to receive the reamer is sufficiently large it should be bored to size with a boring tool rather than attempting to ream it, as a hole more accurate as to size and concentricity will thus be produced, unless we are certain that our lathe spindles are in perfect alignment and the reamer we are using is exactly straight. Many times we find lathes that have been in use for some time have not remained in line, and in fact we occasionally find a new lathe whose spindles are not in line with each other. Now, if the head and tail spindles of a lathe do not line with each other—that is, if one is lower than the other—by moving the tail block in or out we can compensate for the amount the spindles are out of alignment and turn a piece of work straight; but if we attempt to ream a hole in a piece attached to the head spindle by placing the center in the shank end of the reamer on the dead center, when the two spindles are not in alignment, the results will not be satisfactory.

If it is found by trial that the spindles are perfectly aligned, and it is considered advisable to ream the hole, first drill it somewhat small, then by means of a boring tool, bore it to within a few thousandths of an inch of size, to insure its running true. It would not be safe to drill a hole to reaming size, and then ream it without boring, as the drill is almost sure to run somewhat, no matter how much care may be exercised. There is no assurance that steel or iron is perfectly homogeneous, and a soft or hard spot in the stock would cause the drill to run out; for this reason it is always necessary to bore the hole with an inside turning (boring) tool, to make it concentric with the outside of the piece.

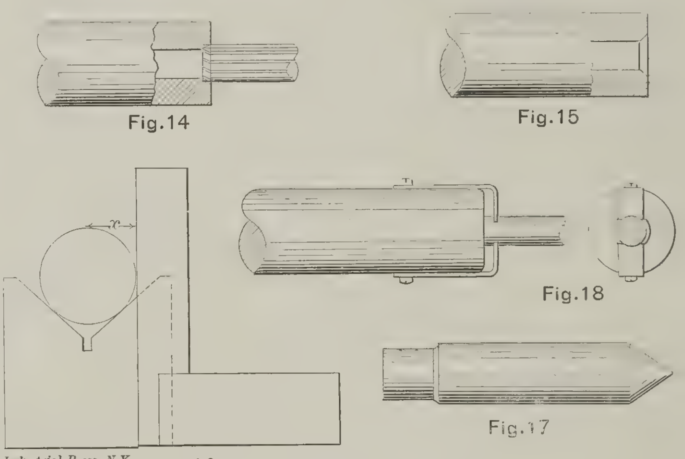
When reaming holes that must run true many mechanics take the precaution to bore the hole to a size at the end—1-16 inch or so—that allows the reamer to be wrung in, as shown in Fig. 14, thus insuring its starting true; and if a rose reamer is *started* true there is every reason to think it will produce a true hole, provided the reamer is straight and in good condition and the spindles are in alignment. Other mechanics who are perhaps equally skillful do not consider it necessary to let the reamer in with the boring tool, but by means of a tool held in the toolpost of the lathe they chamfer the end of the hole, as shown in Fig. 15, to an angle that corresponds to the angle of the cutting edges of the reamer.

A rose reamer will, as a rule, make a hole true to size. If started true the liability of its "running" is reduced to a minimum on account of the large bearing surface it has on its lands which, not being backed off, fill the hole and steady it. This overcomes in a great measure the reamer's tendency to run when it strikes a hard or soft spot, as is the case with a fluted reamer or a drill, which are not supported by the lands—at least not to any considerable degree.

After the hole has been brought to size the holder may be removed from the lathe and the hole for the setscrew drilled and tapped. The burrs are then removed, and when the setscrew is in place it is ready for use. As the pressure of the setscrew is all in one direction the shank of the reamer must fit very nicely in the hole in the holder; the holder must also fit well in the hole in the turret.

To overcome the tendency of the setscrew to throw the reamer to one side, unless the fit be perfect, holders are often made as shown in Fig. 11. The same general instructions given for the other form apply to this except that instead of using a setscrew we drill a hole, *a*, and split the holder as shown. It is quite necessary that the drilling of the hole and cutting of the slots be as nearly central as possible in order that the holder close in a manner that will bring the reamer central. Should the hole *a* be nearer one side of the holder than the other, one side would offer less resistance than the other and the reamer would not be concentric with the holder. Should both sides of the holder not close equally this style of holder is no better than the one using the setscrew to hold the tool.

There are several methods employed when drilling the hole and sawing the slots in holders of this character. The more common way is to center-punch on one side and then drill it in a speed- or engine-lathe, holding the piece in the V-center. The result of using this method would in all probability be a hole drilled to one side of the center of the piece. A better method would be to clamp the holder in a pair of V-blocks on the drill press table, as shown in Fig. 16, locating the punch mark so it is equi-distant from the sides. This can be accomplished by measuring from a square blade placed against the work, as shown, measuring the distance from the blade to the punch mark and setting it so that it measures the same from each side. First drill with a small drill, then follow with a larger one; although a surer way would be to follow with a counterbore. But even with the utmost care the drill is liable to "run" and produce a hole that is not central; so the safest way to drill the hole is to put it between the centers on the milling machine, and drill it by means of a drill held in a chuck, or a collet in the spindle of the machine. The point of the drill should be set at the height of the point of the centers, and when starting to drill, should be set well back in the chuck, having not more than one-half inch of the straight part projecting beyond the jaws. This is to prevent it running when "spotting the work," or in other words, when locating the hole. The work is fed to the drill by means of the cross feed screw handle. Having drilled the hole deep enough to allow the body of the drill to enter the work, withdraw the work and revolve the centers one-half revolution and "spot" the opposite side. The drill is then set out from the chuck and the hole drilled through the walls of the holder, each side being drilled separately from the outside toward the center.



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Figs. 14 to 18. Making a Reamer Holder.

In order that the slots which allow the holder to close together may appear well, hold the piece in the centers, using a metal slitting saw. Set the saw in center of the drilled hole, cut one slot and then revolve the center-head one half revolution and cut the other slot. If this slot were not in the center it would not affect the accuracy of the holder, but how much more mechanical such a piece of work looks when it presents a favorable appearance, and, as a rule, a workman who is slack regarding the appearance of his work is not careful as to essentials. Moreover, as it takes no longer, generally speaking, to do a thing right than to do it in a "slip-shod" manner, it is advisable to cultivate carefulness, not only as to accuracy but as to appearance.

The collar containing the screw used in closing the holder needs no description or explanation as to its construction, as any one can readily see how it is made. Put the small screw shown in cut, in the collar, tapping it into the holder.

This holds the collar in place and prevents its being lost when the holder is laid away if the tension be removed from the setscrew.

When making the form of holder shown in Fig. 12 the same general instructions should be observed, when turning the outside, as with the holder shown in Fig. 11, with the exception of the tapered end and the threaded portion to receive the cap nut used in closing the jaws of the holder. The nut, which is generally made from machine steel, should be made and casehardened before cutting the thread and turning the tapered portion. Caseharden work of this character by dipping in oil rather than water, as the liability of change of shape is then greatly reduced, and the nut will be much stronger.

When possible turn the necessary tapers on this class of work on a lathe having a taper attachment, or a compound rest—preferably the former; the setting over of the dead center is liable to cause the center of the piece being machined to become distorted, thereby throwing the work out of true, i. e., causing one portion to be out of truth with another portion. When there is but one taper to turn on a piece of work it can be accomplished very nicely by setting the dead center over and turning the taper before the straight portion is turned. Then when the centers are placed in line, test the tapered portion before turning the straight portion, and should it prove to be out, the center in the end may be scraped with a three-cornered scraper until the portion runs true. The straight portion may then be turned, and the two will be true one with the other. But where two tapered portions are to be turned on the same piece of work trouble may be experienced unless extreme care is used and the condition of the piece is noted after each operation. Work of this character can be done on lathes having no taper attachment or compound rest, and done in a satisfactory manner, but greater care must be exercised, and the work must be tested after each operation of taper turning.

For the style of holder shown in Fig. 13 we proceed the same as for Fig. 10, when turning the outside portions. The hole in the holder, however, should be somewhat larger than the reamer shank, as shown, but should be concentric with the outside in order that the point of the center may be true with the holder. The center is made from tool steel—a cheaper grade will answer as well as the better quality. It should be turned to a size .010 to .015 inch larger than finish size, and should then be back-rested and the point turned. After this it may be hardened and the temper drawn to a brown color. Harden the entire length of bevel; the angle can then be gaged much more readily when grinding. If it were hard for a part and soft the balance of the taper, the emery wheel would not act alike on the hard and soft portions.

When turning in the lathe it is advisable, when allowable, to turn a portion of one end slightly smaller than finish size, as shown in Fig. 17. When grinding the straight portion to size the dog may be placed on this portion and the straight part ground the entire length. Use a female center for the pointed end, when grinding the straight portion, and after grinding this straight portion, the piece may be back-rested in the grinding machine and the beveled end ground to its proper angle, true with the straight portion.

Now the center may be placed in the holder as shown and a hole drilled through the holder and center and a pin driven in to prevent the center being pressed back, from the force used to cause the reamer to cut. The center, when ground, should be a close fit in the hole; in fact it should be necessary to use gentle blows of a babbitt hammer to drive it to place.

A pin should be driven tightly into a hole in the holder to keep the reamer from turning. The hole in the reamer through which it passes should be considerably larger than the pin; if the pin is ¼ inch diameter the hole should be at least 9-32 inch. For larger size pins the hole should be corresponding above size.

Coil springs are used to keep the reamer central with the holder so that it may readily enter the hole to be reamed. These springs are placed in holes which are tapped to receive screws to give the springs the desired tension. Some mechanics object to the coil springs, claiming that fine chips in the form of grit find their way into the holder, and prevent the springs acting properly. They claim best results with springs made as shown in Fig. 18, which being fastened to the outside of the holder on opposite sides pass over the end and engage with the reamer.

There are other styles of holders in use but those shown give an idea of the operation necessary in making most forms.

* * *

ITEMS OF MECHANICAL INTEREST.

A SPECIAL SHAPER JOB–INSULATING COUPLING–MARINE ENGINE MODEL–DRIVING SCREW SPIKES.

In the operation of New York's electric surface railways, it has been found that the electrical power for propulsion costs less than seven per cent of the total operating expenses.

Twist drills hardened in a water bath should be plunged deep enough to harden a short distance on the shank. Water cracks are apt to occur if the drills are held almost stationary in the water. If the drills are soft, directly back of the water cracks, it is proof that this portion was held at the water line or so close to it that they did not go into the bath deep enough to harden.—*Sparks from the Anvil.*

A SPECIAL USE FOR THE SHAPER.

The accompanying illustration shows the adaptation of one of Gould & Eberhardt's shapers, to work which had previously been considered a milling-machine job.

The machine was designed for cutting the grooves in composition trolley ears, such as are used for suspending trolley wires, and sample ears are shown on top of the vise in the illustration. The machine was gotten out for a large manufacturer, who had been using a milling machine, but wanted to increase his output. With the shaper he has been able to almost treble the output of his milling machine.

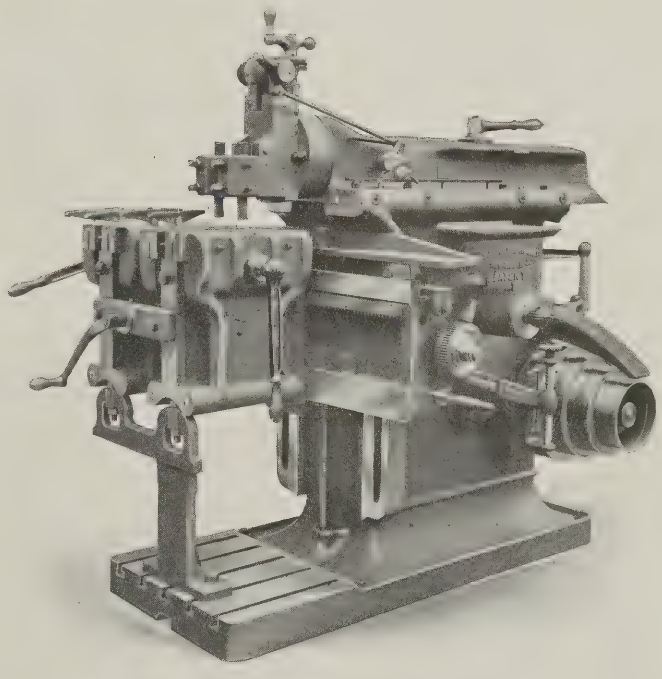
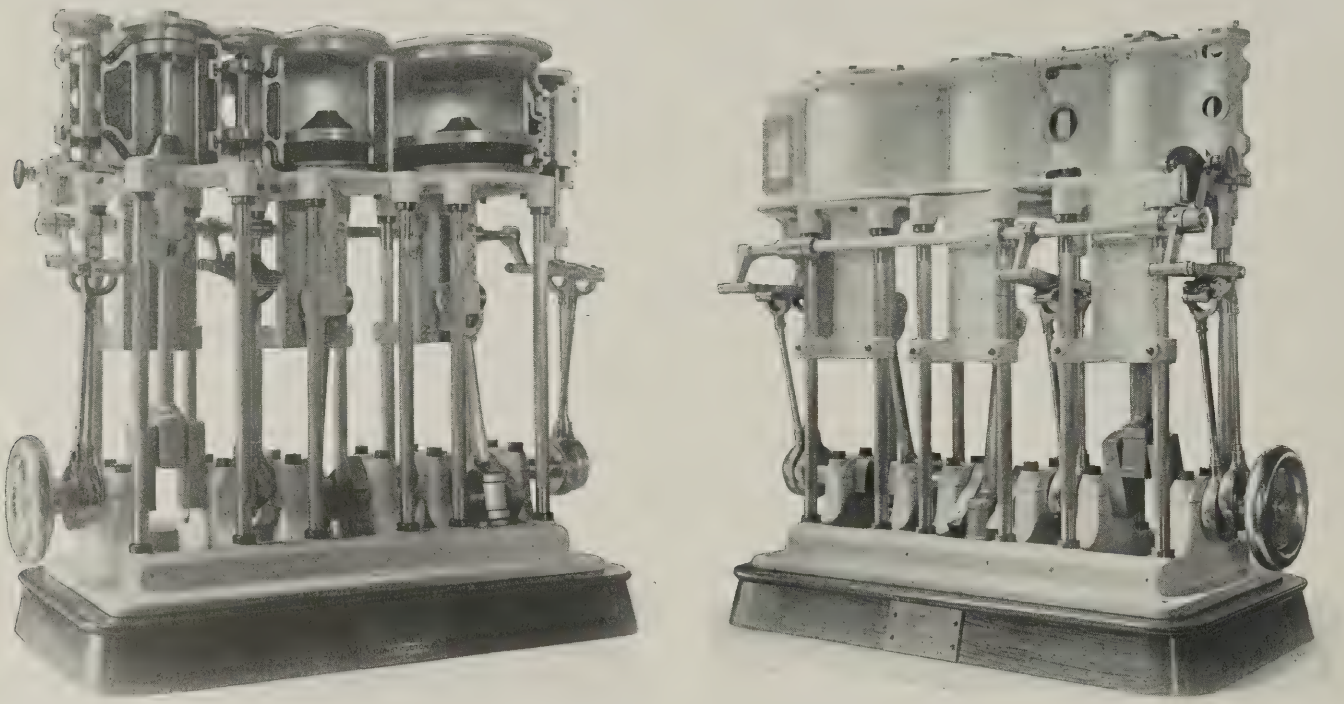


Fig. 1. Cutting Grooves in Trolley Ears.

The shaper is a standard machine, with a special table and tool head. These can be replaced by the regular table and head, and the machine used for ordinary shaper work when required. There are two sets of two vises, four in all, for holding the ears, the jaws of the vises conforming to the shape of the ear. The grooves in two of the ears are planed at one time, the machine being provided with a double tool holder. While this operation is going on the operator removes the ears from the other set of vises and replaces them with blank castings. The tool head has an automatic depth stop, and instantaneous return. As soon as the grooves are planed in the two ears the operator moves the other set of vises over in position, by means of the crank handle on the front, which operates a pinion and rack. The table is provided with a stop at each end which insures its being located centrally under the tools when moved. In the meantime the tool head has commenced to feed down, but there are a sufficient number of strokes allowed for the operator to move the vise over before the tool reaches the work. This machine will plane grooves ⅜-inch wide by 17-32-inch deep and 15 inches long, from the solid casting, at the rate of one every forty seconds.


Figs. 2 and 3. Front and Rear View of Marine Engine Model.

INSULATING COUPLERS FOR MOTOR GENERATORS.

In a description of the transforming and distributing station of the Montreal Light, Heat & Power Co., published in the *Canadian Electrical News*, an insulating and flexible coupling for motor generators is illustrated. It consists of the steel castings *AA′* keyed upon the shafts *CC′* to be coupled. Each casting has eight ears which engage those of the opposite casting through the medium of the rubber rolls *BB*, etc., which are interposed to prevent metallic contact, but which have strength sufficient to transmit the torque. The sides of the ears are grooved to the arc of the rolls and nearly encircle them. Plates over the ends retain them in the recesses and give further support to the rubber rolls. There is of course little flexibility to this coupling, the chief aim being to secure the insulating effect.

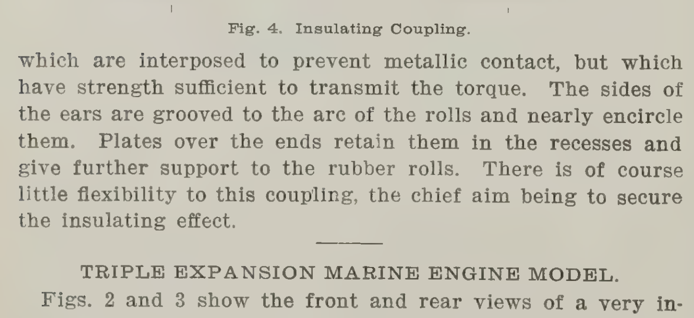


Fig. 4. Insulating Coupling.

TRIPLE EXPANSION MARINE ENGINE MODEL.

Figs. 2 and 3 show the front and rear views of a very interesting model of a triple expansion engine, of the marine type, which was recently furnished the Japanese government for use in the Japanese Naval College. The model represents, to a reduced scale, an engine having cylinders 24, 39 and 60 inches in diameter by 39 inch stroke, and this has been reduced to one-twelfth, giving cylinders 2, 3¼ and 5 inches in diameter by 3¼ inch stroke. The three cylinders and their steam chests are cut open on the front so that their relative movements may be observed as the crank shaft is turned by the hand wheel at the left. The Stephenson link motion is employed for reversing and is operated by a hand lever and knob at the rear of the cylinders. The entire model is about 30 inches in height and is mounted on a neat wooden base. The materials of construction are in nearly all cases the same that would be used in actual practice. All of the steel work is polished and the external cast-iron parts are coated with white enamel paint, so that the engine presents an exceedingly neat appearance as well as affording a correct model for instruction. It was designed by the Gardner Engineering Co., New York City, and built by the Grant Mfg. & Machine Co., Bridgeport, Conn.

MACHINE FOR DRIVING SCREW SPIKES.

Two interesting machines have been built at the Washburn Shops of the Worcester Polytechnic Institute during the last few months under the direction of the United States Bureau of Forestry. These machines are designed for driving screw spikes into railroad ties, and were designed at the Worcester Polytechnic Institute by Alton L. Smith, professor of machine design. The screw spikes are designed to replace the spike ordinarily used by railroad companies, and an effort will be made by the Bureau of Forestry to introduce their use into this country. They are already extensively used in France, Belgium, Germany and other European countries. The advantage of the screw spike lies in the fact that it will allow the use of softer wood for railroad ties than is possible where the ordinary form of spike is employed. The holding power of the latter depends entirely upon the resilience of the wood into which it is driven, and the pounding action caused by the passage of heavy trains over the rails will in a short time loosen the spikes unless the wood employed is firm and close-grained. Of late years the demand for chestnut, oak and other high-grade woods for railroad tie purposes has been so great that railroads have been confronted with a steadily rising price for their tie supplies, and they have been compelled to cast about for something to take their place. In this they have been assisted by the Forestry Department of the Government, which has been, and still is, engaged in an extensive series of experiments along these lines. If the machines which have just been built are successful it is expected that many of the softer kinds of wood, such as spruce and poplar, can be employed for railroad ties. With the old form of spike, experiment has shown that the life of one of these ties did not exceed six or eight months, but with the screw spike it is expected that they will last for some years. One of the machines in question was built for the New York Central, and the other for the Pennsylvania Railroad Company.

HOW AND WHY.

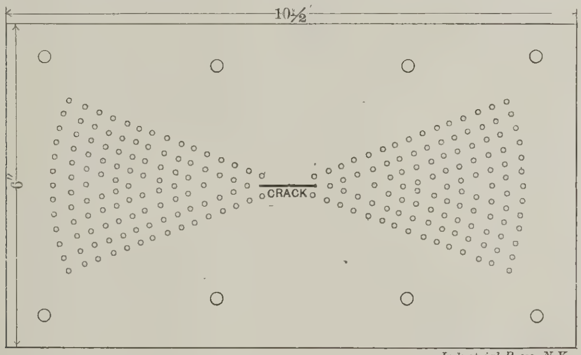
A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

14. W.—1. In hardening tools made of the new process steels, is an air blast employed or are the tools simply left to cool off in the atmosphere? 2. How can tools made of these steels be annealed?

A.—1. Tools of the new process steels should be hardened either in an air blast or in oil. Generally the former method is used for such tools as lathe and planer tools, while the oil bath is used for such tools as milling cutters, taps, etc.. For air hardening, bring the tool to a white welding heat and place it at once in a strong blast, holding it a few inches from the outlet. Do not remove the tool until it is quite cold. For oil hardening, bring the tool to a white pimpling heat, then lay it on the anvil or floor and allow it to cool down to a black heat, showing a dull red in shadow or dark place. Brush the tool off and place in the oil bath. Precaution should be taken in placing it in the oil, for if too hot the steel is liable to crack. 2. To anneal these steels, heat slowly but thoroughly to a yellow color and pack at once in a steel box or tube with dry fire clay so that the air cannot come in contact with the steel. Lime, charcoal and sea sand are recommended for use in place of fire clay, and if one of these substances does not give satisfactory results with any particular brand of steel, it is well to try one of the others. If an air-tight box or receptacle is available the steel may be annealed by heating it in this box and then allowing it to cool off slowly. It is a good plan to let the box containing the steel remain in the furnace while the fire is dying out.

15. D. M. M.—The accompanying sketch shows a perforating die that I made with very poor results. The die was 6 by 10½ inches by one inch thick, and cracked in hardening. The holes were 1-16 inch diameter and spaced ¼ inch. The die cracked at the point marked, and I am at a loss to know why it cracked at the heaviest place. I heated it in a charcoal fire to a cherry red and dipped it, side up. The bath was a large tub of clean water, with a half pail of salt in it. Any information that you can give me will be appreciated.



Industrial Press, N.Y.

Answered by E. R. Markham.

The crack was the result, undoubtedly, of unequal contraction, there being a greater volume of stock between the point where the crack occurred and the sides of the die than at any other portion, and the contraction was not only greater, but continued for a longer time. As the die was cut away less at this point than any other the yielding space was reduced to a very narrow space. What is more natural, with a greater volume of stock to contract, and the portion cut away reduced to the minimum—as per the sketch—than that it should break at this point?

There are several methods whereby a die of this character can be hardened with comparative safety. The safest method, and one I have never known to fail, consists in hardening by the method known as pack hardening. This has been explained in several articles the writer contributed to MACHINERY, but as the application would be somewhat different in the case under consideration, it will be explained in a brief manner. Pack the die in a hardening box with granulated charred leather and subject to a low red heat in a furnace for about 3½ hours after the *die* is red hot. It may then be taken from the box and dipped in a bath of raw linseed oil. There should be a pump connected with the bath whereby a volume of oil can be forced against the face of the die and through the holes. The oil used should not be cold, but about 60 degrees Fahr. Since every shop is not equipped with the necessary apparatus to pack harden work satisfactorily, we will consider a method that can be applied anywhere, provided we have a suitable fire and a supply of water. First take a block of cast iron somewhat longer and wider than the die block, then cut out the center the shape of Fig. 1. The double angular-shaped opening must be about one inch larger each way than the perforated portion of die, which would make the opening one-half inch larger each way than the space taken up by the perforations. The die must be heated *uniformly* to a low red, taken from the fire and laid flat with the face uppermost. It will be necessary to lay it on two strips of iron to block the back up somewhat, so the water that passes through the holes can run off readily. Place the cast-iron piece, Fig. 1, on the face of the die, having an equal space around the perforated portion, then by means of an overhead pipe like Fig. 2, a stream of water can be run onto the exposed portion of die; and, as the balance of the die is protected by the plate, it will not be hardened, consequently there will be no contraction to speak of that will have a tendency to draw the stock from the center.

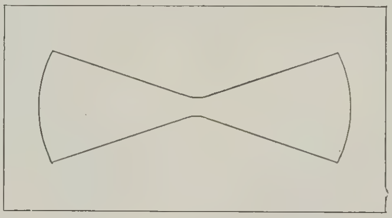
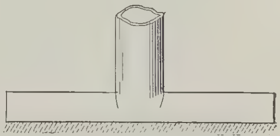


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

If we have a tank of oil it is advisable to plunge the die in the oil as soon as the center is hardened and allow it to remain until cool. When cool reheat to remove strains, then draw temper. Do not use *cold* water. Water at about 70 degrees Fahr. will not be as liable to cause the die to crack.

16. S. H. S.—Are the rolls that are used for making steel plate of cast steel or iron?

Answered by J. W. Bourn, Philadelphia, Pa.

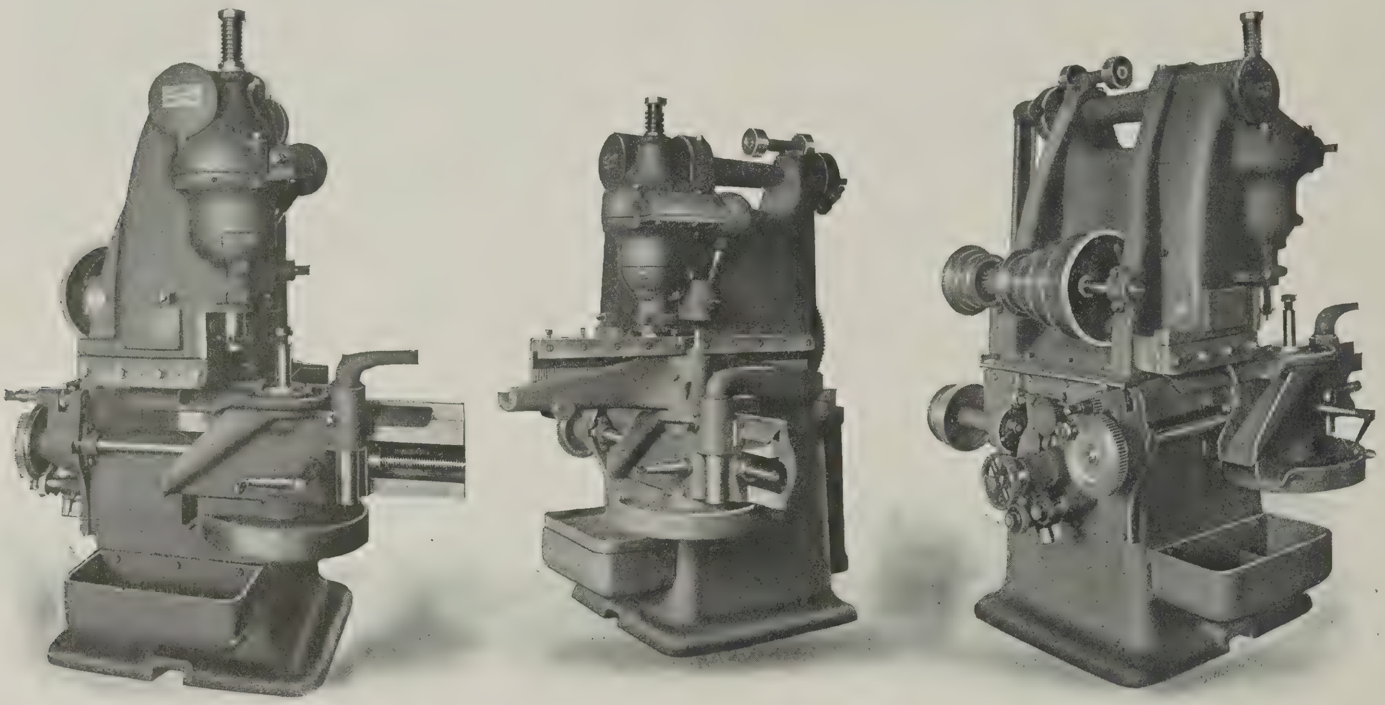
Rolls for steel, iron, brass, or tinplate are invariably made of chilled cast iron, while for rolling bars of various shapes and materials, steel rolls are quite extensively and successfully used, but they are more expensive than those of cast iron. The steel is too soft for plate rolling, and it is very difficult to obtain steel castings that will have perfectly clean surfaces when they are turned, it being a requirement of plate rolls of any description that the surface shall be practically perfect. To make a steel roll, either cast or forged, it would have to be hardened and ground after turning and in addition to being a very expensive job, it would not be very serviceable since, except for cold rolling which is comparatively rare, the hot metal would soon draw the temper and leave the roll too soft for use. Cast iron, on the other hand, can be cast without a flaw, turned easily and cheaply, and can be chilled to any depth, making a surface that cannot be softened by the heat of the plate. Steel rolls hardened and ground ready for use would probably cost from 50 to 60 cents per pound, with all the chances against their doing the work, while good chilled rolls have been known by the writer to be made as cheap as 7 or 8 cents per pound.

* * *

After many months of fighting, the Wabash R. R. some time ago secured entrance into Pittsburg. The railroad emerges from a tunnel through the hill opposite Pittsburg, crosses the Monongahela River on a double-track cantilever bridge, and enters the city hard by the old Hostetter plant, of stomach bitters fame. The bridge, which is now well along, will be the largest cantilever bridge in this country, having a clear span of 812 feet over the river. It is said that the largest eye-bars ever made will be used in its construction. No false work will be erected for the river span.

NEW DESIGN OF FELLOWS GEAR SHAPER.

A gear shaper of new design has been brought out by the Fellows Gear Shaper Company, Springfield, Vt. It is a smaller machine than the original shaper which this company have manufactured since their inception six years ago, and is built to do rapid and accurate work on small and medium-size gears of comparatively fine pitch. It will operate on blanks up to 24 inches in diameter and of 4-inch face, and is designed to cut teeth of 8-pitch and finer.



Figs 1 to 3. New Design of Fellows Gear Shaper.

The machine is quite different in appearance from the larger one, and its mechanism is different in several important particulars. The same principle of tooth formation is employed, however, which Mr. Fellows so neatly worked out for his first machine. The cutter used is a tool-steel pinion, having teeth ground with a suitable rake and clearance, and as it reciprocates, both the cutter and blank are given slow rotary motions in the inverse ratios of their pitch diameters. The teeth of the cutter thus plane out teeth in the gear blank which are conjugate to the teeth in the cutter.

In the original Fellows gear shaper provision was made for clearing the cutting edges of the cutter upon the return stroke by a slight backward-and-forward movement of the casting which supports the work arbor and carries the blank to be cut, this motion taking place at each reversal of the stroke of the cutter bar. In the new machine, however,

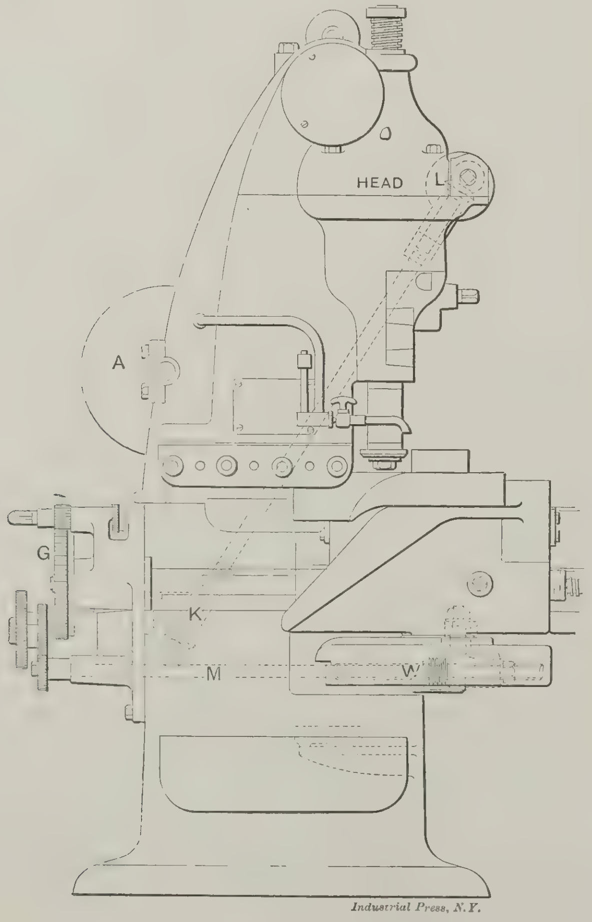


Fig. 4. Front View of Fellows Gear Shaper.

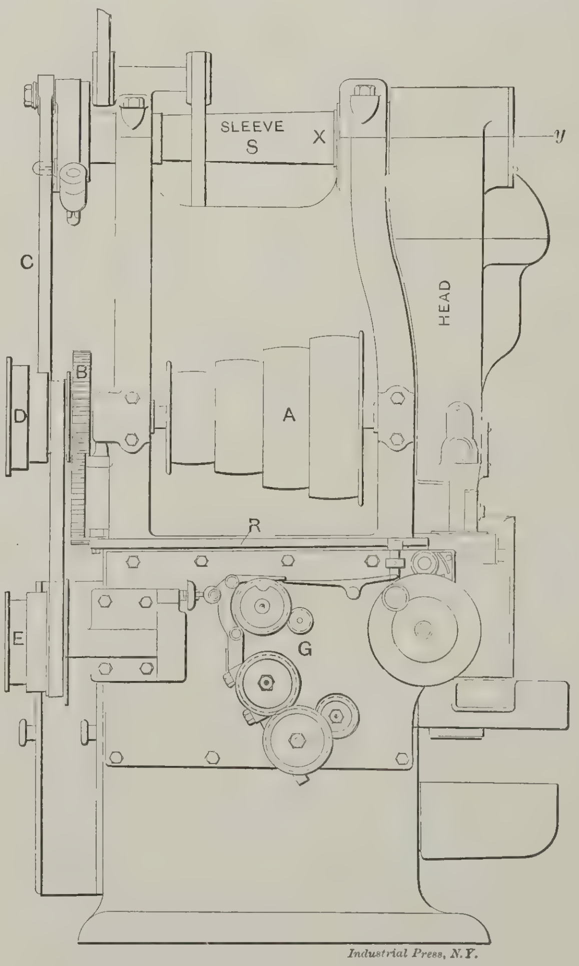
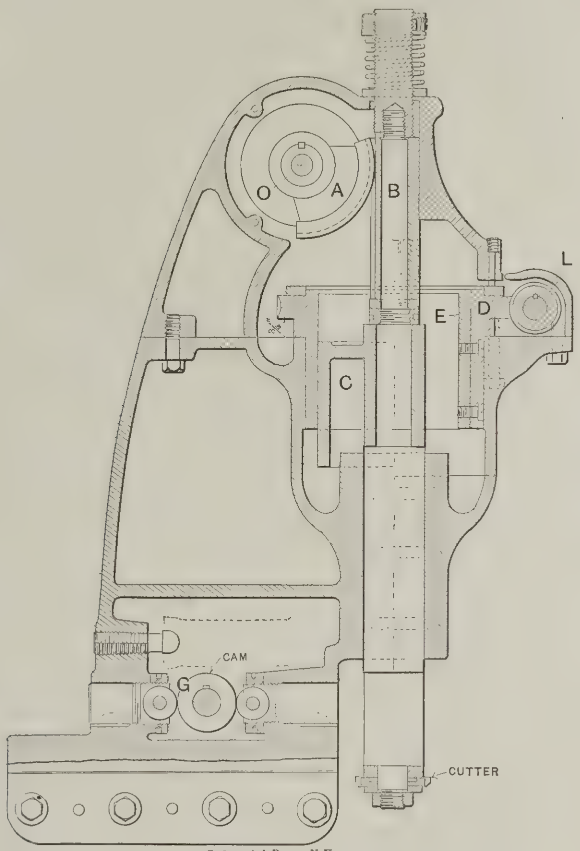


Fig. 5. End View of Fellows Gear Shaper.

the carriage remains fixed and the tool clearance is obtained by a slight rocking motion of the head, which carries the cutter bar. By this construction the machine is adapted for the use of a rack-cutting attachment, which is attached to the carriage, and receives its feed from a pinion on the work arbor. Owing to the reciprocating motion of the carriage of the older machine, no rack-cutting attachment was made for it, as it was considered that the carriage and rack-cutting attachment combined would be too great a mass to be moved back and forth rapidly at each stroke of the cutter. The new type of machine therefore has the advantage of the rack attachment, and at the same time is convenient and rapid for gear cutting within its capacity. It is not, however, adapted for cutting internal gears.

In the half-tone illustrations, Fig. 1 is a front view of the machine. The whole visible front of the upright constitutes the head, which carries the cutter bar and connections. The head is pivoted at the top and its rocking motion is derived from a small rotary cam at its base. The alignment of the head is maintained by a heavy gib which bears against a flat, finished surface at the bottom. The carriage for supporting the work is carried by an overhanging arm, to which it is gibbed, and along which it can be moved for adjustment of the work to the cutter and for feeding the work against the cutter at the start. Channels cast in the carriage carry chips and lubricant to the pan bolted to the base of the machine.



Industrial Press, N.Y.

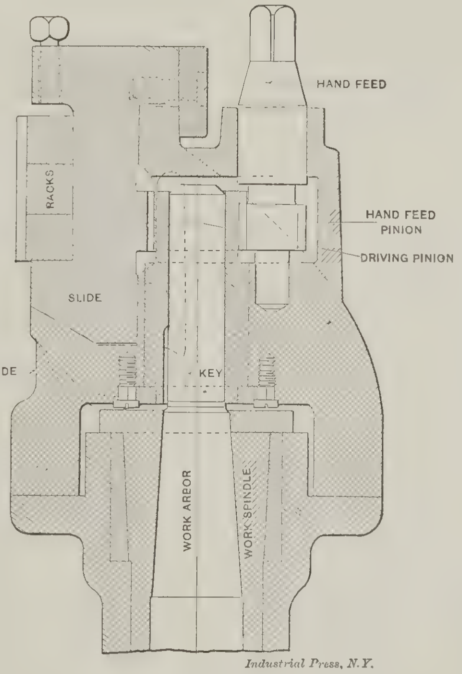
Fig. 6. Section through Head of Fellows Gear Shaper.

Fig. 3 is an end view, showing the driving cone and feed gears, which in this machine correspond to the spacing mechanism of the ordinary gear cutter. This view also shows more clearly the arrangement of the gib at the base of the cutter head.

The middle view of the group, Fig. 2, shows the rack-cutting attachment in place. This consists of a frame, which fits over the work spindle and rests on the top of the carriage, and a heavy slide in which the rack blanks are clamped. This slide advances as the cutter rotates, deriving its motion from a pinion on top of the work arbor, which meshes in the teeth of the rack visible in Fig. 2 at the back of the slide. In Fig. 7 is a sectional engraving of the attachment, in which the different parts are indicated with sufficient clearness to make further description unnecessary.

Figs. 4 and 5, respectively, present a front and end view, in which corresponding parts are similarly lettered. Power is received at the driving cone *A* and transmitted through gears *B*, to a horizontal shaft parallel with the driving shaft, but not visible in the engraving. This shaft passes through the machine and at its right-hand end, Fig. 5, carries the cam for giving the head the oscillating motion. At its left-hand end is an adjustable crank, from which the connecting rod *C* transmits motion to a shaft passing across the top of the machine, through the sleeve *S*. This latter shaft thus has an oscillating motion which it transmits to the cutter bar by means of a rack and segment. At the left-hand end of the shaft referred to as being driven by gears *B*, is also a cam which gives motion by rod *R* to the carriage feed screw, and feeds the work against the cutter to the required depth, when beginning to cut a gear.

On the left-hand end of the driving spindle, Fig. 5, is the feed cone *D*, which is belted to cone *E*, connected with the feed gears *G*. This train of gears, *G*, gives the rotary motion to the cutter bar and the work arbor, the change gears used determining the relative rates of rotation of these two members. The motion is transmitted to the head for rotating the cutter bar by means of the inclined shaft *K L*, Fig. 4, and to the work arbor by the shaft *M* and the worm and worm-wheel *W*.



Industrial Press, N.Y.

Fig. 7. Rack Cutting Attachment.

The head, Fig. 5, swings about the axis $x\ y$ and is supported upon an extension of the sleeve *S*, which passes through the frame and extends about half-way into the head, which is bored to receive it. The head is shown in vertical section in Fig. 6. The cutter bar is balanced by the spring at the top, and on its upper end is the sleeve *B*, on which rack teeth are cut to mesh with teeth on segment *A*, keyed to shaft *O*. This shaft is driven by the crank motion, as before explained and gives the reciprocating motion to the cutter and cutter bar. The cutter bar is rotated by the worm *L* and worm-wheel *D*, which latter has a long hub bored out to receive the segmental casting *C*, which is fast to the cutter bar. The vertical edges of segment piece *C* bear against the vertical edges of an annular piece *E*, which fits inside the hub of worm-wheel *D* and is fastened to it. This construction is the same that was adopted some time ago by the Fellows Gear Shaper Company and has already been described in these columns. The object of the arrangement is to allow the bar to reciprocate within the worm-wheel and to receive its rotary motion from the worm-wheel through the contact of sliding surfaces sufficiently removed from the axis of the bar to make any wear of these sliding surfaces negligible in so far as it affects the rotary motion of the cutter.

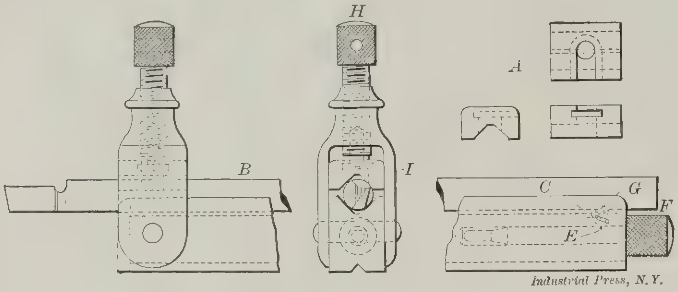
At *G* in Fig. 6 is the rotary cam which causes the head to rock about the center *O* for the relief of the cutter on the return stroke.

LETTERS UPON PRACTICAL SUBJECTS.

A HANDY BORING TOOL HOLDER.

Editor MACHINERY:

The writer would suggest a slight improvement in the boring tool holder shown in the August number of MACHINERY by Mr. E. H. R. In such a holder, where round tools are used, it is wise to place a shoe under the clamping screw and thus prevent the end of the latter from coming in contact with the tool. Such a shoe as is shown at *A* in the accompanying sketch will be found very satisfactory. This is slipped in place before the tool holder is assembled, the screw *I* being slid into the slot in the side and the screw driver being operated through the center hole. This screw should be a free fit in the shoe which it prevents from falling out and holds it always in its right place. This shoe should be cleared slightly in the center to insure its bearing properly at each end.



Boring Tool Holder.

The clamping post is arranged to swing on the pin connecting it with the body and when not in use as a tool holder, this post may be straightened out and the tool used for drill holder in connection with lathe work. With this holder the operator can feel the tension on the drill and is thus able to prevent many breakages. A hole drilled in the end of the shank carries a bar *F* which is used for tightening the binding screw. When not in use this bar is held in the shank by the pressure of the plunger *E* and spiral spring *C*, which is retained by a small screw *G*.

It often happens that one is required to bore a comparatively long and smooth hole for which no reamer is provided and, in such a case, the side tool *B* will be found to work very satisfactorily. It should be always set with the point leading slightly, as it is not the point but the side of the tool that is to do the cutting.

A. L. MONRAD.

New Haven, Conn.

"BABBITT METAL."

Editor MACHINERY:

In the November issue of MACHINERY is the quotation from *Metal Industry* claiming for Isaac Babbitt the invention of the idea of lining boxes and bearings with an antifriction metal, known as "Babbitt" metal, the patent of which was no doubt applied for and granted in good faith. My grandfather being identified with the Norris works in Philadelphia, and afterward with the mechanical department of the old "State road" at Parkesburg, Pa., was the inventor of a lining metal which he called "composition." At that time driving boxes (which were solid brass), engine trucks, and tender brasses, and crosshead gibs and rod brasses as they became worn, were refilled to their original size, with this "composition." My father being the brass molder at the Parkesburg shops, made and used the composition as required, in the locomotive repairs. As I became strong enough to go into the brass foundry, taking the place of an older brother, I mixed and used a great deal of the "composition." The ingredients were tin, copper, antimony. I don't know what the proportions of copper and antimony were, as my father always mixed it in a crucible and poured it into molds, convenient for breaking up. This mixture was called "hardening," and had a bright crystalline appearance at the broken surface. The composition was made by melting in an iron basin, four parts of block tin, and one part of the hardening. The tin was melted first. There was no patent on it that I am aware of. The mixture was a family secret, well kept. I did know at one time what were the proportions of copper and antimony, but have forgotten it. My father had been making and using this composition when I was in infancy, and I am now very near my sixty-seventh birthday. As I grew up to boyhood, and began to notice things, I often heard the old railroad men speak of the "old man's composition." Its wearing qualities were wonderful, and it would run cool, when applied to journal bearings.

W. DE SANNO.

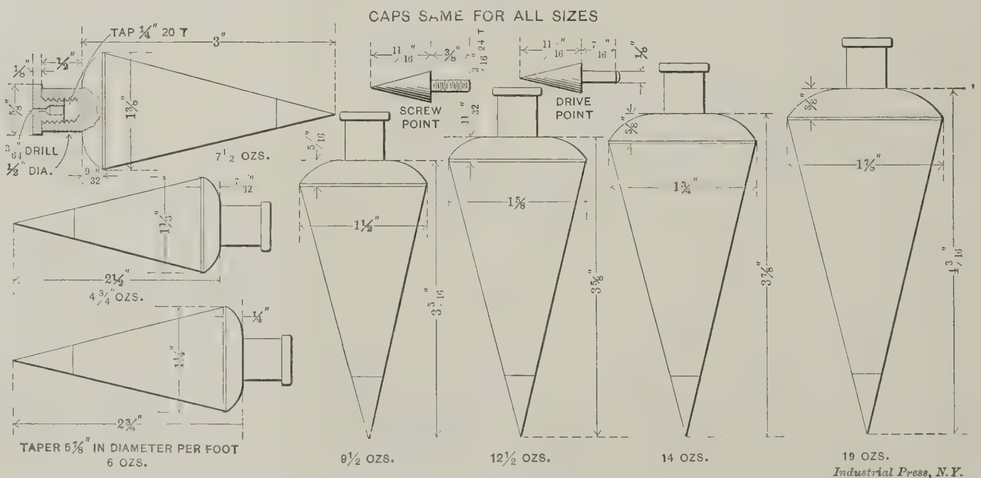
San Francisco, Cal.

DESIGN OF A MACHINIST'S PLUMB BOB.

Editor MACHINERY:

A fine plumb seems to be one of the instruments that is used in almost every trade as a kind of master instrument by which the work done by other tools is checked or proven, so that it is very natural that every mechanic should prize such an instrument. Of course there are many ways and styles in which these plumb bobs may be made, but those shown in the accompanying details will be found admirably suited for use on the better class of surveying instruments and for fine machine work in erecting and adjusting machine tools, engines and other things requiring to be accurately set.

The drawing shows seven sizes ranging in weight from 4¾ to 19 ounces. They should be made of cast brass or bronze or of bar brass, but in no case should cast-iron be employed, because at the present time the use of electricity is so common that a cast-iron plumb bob is often drawn out of its proper position by some local attraction. For this same reason the steel points are made comparatively small. The cap that screws into the head to receive the string or line should be knurled on the edges so as to be readily screwed in or out. The points, either drive or screw, should be made of machine steel and casehardened. These directions, with the detailed measurements given, should enable the machinist with very little trouble to construct a very handy plumb bob of almost any size that he is likely to wish.



Details of Plumb Bobs from 4 3-4 ounces to 19 ounces.

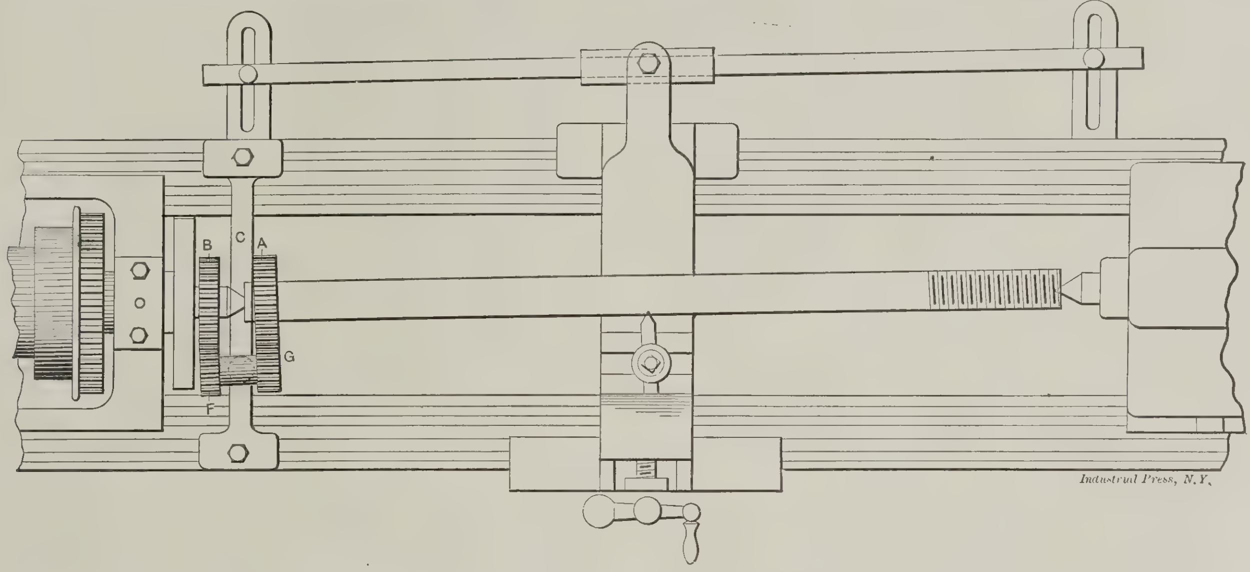
Burlington, Iowa.

F. W. SALMON.

ACCURATE THREADING OF TAPS AND DIE HOBS.

Editor MACHINERY:

Experience in tap and die making has taught that it is one thing to make a perfect screw and quite another to make a tap which will perfectly correspond with it. It is well known that a tap shortens in tempering, this shrinkage varying somewhat with different grades of steel, so that a tap and a screw made with the same leadscrew will not correspond in pitch. Therefore to be accurate, allowance must be made in chasing the thread on the tap for the shrinkage that is to take place in the hardening.



Method of Cutting Taps and Hobs with Allowance for Shrinkage in Hardening.

To carry out this idea a little further: A hob and a tap may thus be made to correspond but after a die is hobbed and tempered it will not exactly match the hob or the tap which it is intended to suit. So we see that the hob should be made with an allowance of two shrinkages to counteract the shortening that takes place when it (the hob) is hardened and again when the die is hardened. While it is not the best policy to make taps and dies in the tool room it often becomes necessary to do so for sizes varying from the standard, and the problem then presents itself to cut them so as to make the proper allowance for shrinkage. The following method shows how the writer has accomplished this in a very satisfactory manner:

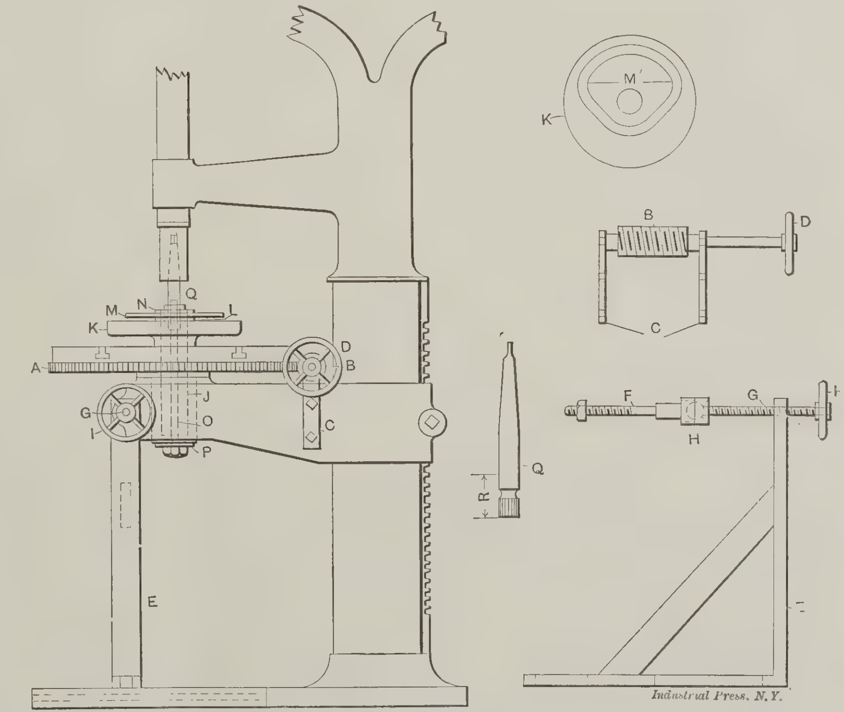
The change gears of the lathe are first arranged as usual for cutting the required number of threads per inch. The tailstock is then set over either way for a short distance and the taper attachment is set to correspond with the set-over of the tap. The thread is then cut as usual, the tool being set by the face of the tap. The thread cut in this way will be slightly coarser than would have been the case if the centers were in line with the axis of the lathe. The reason for this will be obvious from the illustration, and a little practice will enable the machinist to judge just how much the tailstock should be set over to obtain the required result. For example: If the tap is 10 inches long and is set over ½ inch, while the tool is moving the whole length of the tap, the movement of the carriage parallel to the axis of the lathe would be through a distance of but 9.987 inches, so that the thread is lengthened .013 inch; in other words, there are as many threads in 10 inches on the tap as would have been cut in 9.987 inches had the centers been in line with the shears.

If now in cutting this tap we were to use an ordinary dog, driven from the faceplate, it will be apparent that the result would be a drunken thread, since the velocity of revolution of the tap would not be constant throughout its revolution but would be variable; so some means for driving is required that will transmit a uniform motion from the spindle to the tap. To accomplish this a small gear *A* is mounted upon the end of the tap, and a similar gear *B* is attached to the live center or to the faceplate. A fixture *C* is used for supporting a short shaft on each end of which is placed a pinion, as shown at *F* and *G*. These pinions are of the same size and engage with the gears *A* and *B*. When they are properly adjusted so as to run freely with these gears, they impart a perfectly uniform movement to the tap which is being chased. QUIRK.

CAM MILLING IN THE DRILL PRESS.

Editor MACHINERY:

Some years ago while building automatic machinery in a small shop connected with a manufacturing plant, the writer had occasion to cut a number of cast iron face cams, which were all different and varied in size from 6 to 14 inches in diameter. After an amount of consideration it was decided that we could cut these cams upon the drill press cheaper than we would be able to get them cut elsewhere.



Drill Press Arranged for Cam Milling.

The press available was of the ordinary upright type and to fit it for this work the plate was taken off and bored out to 1 15-16 inch. Then the lower edge of its periphery was turned to accommodate a strip of steel rack, *A*, ½ inch wide and about 14 pitch, which was procured from the stock of a gear manufacturing company. This rack was bent and fastened to the plate by screws passed through clearance holes in the rim of the plate and tapped into the rack. When this was in place it made a very good substitute for a worm wheel, and a piece of steel, *B*, was turned up and threaded to correspond with it. As the space between the post of the drill press and the plate was only 1¼ inch it was found necessary to place the worm at a slight angle in order to give the thread as good a bearing as possible on the teeth of the rack. Two pieces of ½ x 1½ inch wrought iron, *C*, were cut and drilled to fit the reduced ends of the worm shaft, and these were then bolted on each side of the arm, supporting the plate in a position to allow the worm to mesh properly with the worm wheel. A handwheel, *D*, procured from an old valve, was fastened to the end of the worm shaft with a pin and this completed the rotary feeding mechanism.

The table and its supporting arm were free to swing around the post of the drill and were fed around by means of the mechanism shown at the right of the cut. The angle, *E*, had a long bolt, *G*, tapped into its upper end and the head of this bolt was turned to a ball shape which fitted easily in the socket, *H*. This socket was made in two parts and screwed into the hole previously occupied by the clamping bolt in the end of the supporting arm. The shank of this socket bolt was made a snug fit in the arm so that it would be rigid without interfering with the free rotation of the plate.

Upon a sheet of soft steel, 3-16 inch thick, the different cams were laid out and each carefully cut out to the exact size of the inside of the groove in the cam, as shown at *M* in the sample cam, *K*. As all of the cams were to be keyed to the same shaft, both cams and templets were bored to 1 15-16 inch, the exact position of the keyway being left to be determined by trial when the machine was assembled. A short piece of 1 15-16 inch shaft, *J*, which was a snug fit in the hole of the plate, was drilled to clearance for ¾-inch bolt, *O*, and a washer *P* was provided large enough to cover the hole at the bottom of the plate hub. The cam blanks were mounted, face upward, on the piece of shafting, then a collar, *L*, about ¼ inch thick was placed on the cam and above this the templet, *M*. A large washer, *N*, and the ¾-inch bolt then clamped the whole firmly to the plate.

For cutting the cams we made a right-hand end mill, *Q*, with a short length of the body the same size as the cutting edges, and hardened for a distance up the shank indicated by *R*. The shank of this cutter was made No. 3 Morse taper to fit the drill spindle socket.

The concentric portions of the groove were produced by simply turning the worm *B* by means of the hand wheel, and the rise and fall of the cam was produced by using both feeds simultaneously, keeping the body of the mill against the templet, the edges of which were moistened with oil. In order to make as little side thrust as possible the cams were cast with grooves, which allowed about 1-16 inch finish on each side, and they were thoroughly pickled to save the corners of the mill. The cams produced were equal to those made with more expensive and intricate mechanism, and having the templet at hand, it was a simple matter to replace any cam that became sufficiently worn to require it. F. W. A.

Philadelphia, Pa.

FIGURING A PAIR OF SPIRAL GEARS.

Editor MACHINERY:

Perhaps there has already been enough said about spiral gears without this sketch, but it contains an idea or two that appealed to the author as a little different from any seen before. It was desired to make a pair of spiral gears with a ratio of one to four and with pitch diameters about 2½ and 6 inches. Of course from the start we should not expect to obtain exactly these pitch diameters with spiral gears (although it might happen) any more than we would expect to get diameters 1½ to 6 with a 5 diametral pitch cutter and a ratio of 1 to 4 on spur gears.

The spiral gears are to be cut with a 6 diametral pitch cutter. As the diametral ratio of 2½ to 6 is the same as 1 to 2.4, this ratio must be taken into account in the total ratio of 1 to 4; therefore the angles of the teeth must be such that it will be the quotient of the ratio 1 to 4 divided by 1 to 2.4, or 4 to 2.4, which is equal to 1.666 to 1.

By constructing a triangle with 1.666 as one leg and 1 as the other then the hypothenuse will represent the angle of the teeth, where the acute angle adjacent the long leg is the angle of the larger gear, and the acute angle adjacent the short leg of the triangle is the angle of the smaller gear or pinion.

Thus we have the ratio of the angles of a triangle. The tangent $= \frac{\text{opposite side}}{\text{adjacent side}}$ or the tangent of the angle of the pinion is equal to 1.666, which is the tangent of 59 + degrees, and its complement 31— degrees for the angle of the teeth of the gear. These are only our trial angles. In the following equations let

$C.P =$ Circular pitch measured according to spur gears;
$N =$ the number of teeth in a gear;
$P\ D =$ pitch diameter;
$\pi = 3.1416$;
Sec. = secant of angle of teeth with axes of gear.

Then $\frac{C\,P \times \text{sec.} \times N}{\pi} = P\ D$ on any spiral.

The corresponding circular pitch of a 6 diametral pitch cutter is equal to $\pi \div 6 = .5236$.

Transposing the first equation $N = \frac{P\ D \times \pi}{C\ P \times \text{sec.}}$ and substituting $\frac{6 \times 3.1416}{.5236 \times 1.166} = \frac{18.84}{.6105} = 30.85$ as the number of teeth. We cannot have this number of teeth in the gear, and 31 would not be divisible by 4, as the ratio must be 1 to 4, so 32 and 8 must be taken as the required number of teeth in the gear and pinion respectively. This will increase the pitch diameter, but as eight teeth will make quite a small pinion, it was thought advisable to make it larger, rather than smaller, for although 28 and 7 could be taken just as well, this would make the total number of teeth 3½ smaller than the first result of 30.8 and 7.7, whereas 32 and 8 make the total only 1½ teeth larger.

The example up to this point can be worked in a very short time on the slide rule and save much work. Using the *C* and *D* scales take the approximate pitch diameters 6 and 2½, place 6 on the *C* scale opposite 2½ on the *D* scale, and over the left-hand index read 2.4 on the *C* scale. Place 2.4 on *C* scale over 4 on *D* scale, and over right-hand index read .6 on *C* scale. If the rule has a slot in both ends on the back, simply transfer the slide so that 6 on the *C* scale is over left-hand index of *D* and read 31 degrees nearly on the scale of tangents. If the rule has no slot in the left-hand end, invert the slide and over 6 on *D* scale read 31 degrees nearly on the scale of tangents.

In a trigonometrical table look up the secant of 31 degrees and find 1.166, and then find the corresponding circular pitch for 6 diametral pitch equal to .5236. Set left-hand index of *C* to 1.166 on *D*, and opposite .523 on *C* read .61 on *D*. Then place right-hand index of *C* opposite 6 on *D* and set runner to 3.14 on *C*; set .61 on *C* to runner, and under right-hand index of *C* read 30.9 as the number of teeth, which gives very nearly the same number as before. Using the first equation again: $\frac{C\,P \times \text{sec.} \times N}{\pi} = P\ D$ and transposing $\frac{C\,P \times N}{\pi \times P\,D} = \frac{1}{\text{sec.}}$ or $\frac{\pi \times P\,D}{C\,P \times N} = \text{sec.}$, substituting $\frac{3.1416 \times 6}{.5236 \times 32} = \frac{18.8496}{16.7552} = 1.125$, which is the secant of 27 degrees 16 minutes.

But in the above substitution the number of teeth was increased from 30.85 to 32 and the pitch diameter was not increased because we do not know how much to add, therefore we should expect that this angle would be too small. For the sum of the angles of the teeth with the axis of the gear and pinion should equal 90 degrees; therefore the angle of the teeth of the pinion will have to be found by the same formula as the gear.

$\frac{\pi \times P\,D}{C\,P \times N} = \text{sec.}$; substituting, $\frac{3.1416 \times 2\frac{1}{2}}{.5236 \times 8} = \frac{7.854}{4.1888} = 1.875$, which is the secant of 57 deg. 46 min. 27 deg. 15 min. plus 57 deg. 46 min. is equal to 85 deg. 02 min. This subtracted from 90 deg. = 4 deg. 58 min., which shows that the numerator of the fraction must be increased, therefore the pitch diameters 2½ and 6 must be increased, as the other factor is a constant.

The ratio we have found for the angles is 1 to 1.666, so we must increase the angles in this proportion. $1 + 1.666 = 2.666$.

4 deg. 58 min. = 298 min.

298 divided by 2.666 = 112 min.

$112 \times 1.666 = 186 +$ min.

112 min. = 1 deg. 52 min. This must be added to the angle of the gear, which was 27 deg. 16 min, making it now 29 deg. 8 min.

Also 186 min. = 3 deg. 6 min. and this added to 57 deg. 46 min. = 60 deg. 52 min. Taking the first equation once more and working to get the correct pitch diameters with these new angles, we have $\frac{C P \times \text{sec.} \times N}{\pi} = P\ D$; substituting $\frac{.5236 \times 1.1448 \times 32}{3.1416} = 6.105$, which is the pitch diameter of the gear of 32 teeth.

Also for the pinion $\frac{C P \times \text{sec.} \times N}{\pi} = P\ D$; substituting $\frac{.5236 \times 2.0541 \times 8}{3.1416} = 2.738$, which is the correct pitch diameter of the pinion of 8 teeth.

Therefore our example stands as follows:

6 diametral pitch cutter used.

	Pinion	Gear.
Number of teeth	8	32
Ratio of speed	4	1
Angles with axis	60 deg. 52 min.	29 deg. 8 min.
Pitch diameters	2.738 inches	6.105 inches

A relation for instance in a worm and worm gear, is that the pitch circumference of a worm gear divided by the ratio of the worm to gear, is equal to the lead of the worm. The same thing will hold true of a pair of spiral gears, for they are only modified worm gears. Therefore the pitch circumference of the large spiral gear, which is 19.1813 divided by the ratio 4, equals 4.7953. This should be the lead of the small spiral pinion. The lead of a spiral gear equals the pitch circumference divided by the tangent of the angle of the teeth. The pitch circumference of the pinion equals 8.6042; divide this by tangent of 60 deg. 52 min. = 1.79214, and we get the result 4.7955, which proves that the gears are correct.

E. M. Willson.

SOME SUGGESTIONS FOR DIE MAKING.

Editor Machinery:

In traveling around from one shop to another it is very interesting to the tool maker or die maker to note the different methods that are employed for the production of practically the same pieces of work. The writer remembers building, some time ago, the die shown in Fig. 2, which was designed by Mr. Thomas Gierding, of the New Haven Clock Company. This die performed five distinct operations before the piece shown in Fig. 1 dropped completed from the press. Recently in visiting a factory, I was somewhat amused to find three presses employing the services of three pressmen occupied in producing exactly the same piece.

In constructing this die it was not deemed practicable to make it of one solid piece since one small flaw would, in this case, spoil the entire die. A die block of machine steel was therefore used, having recesses counterbored for the insertion of tool steel bushings. These recesses were accurately spaced by the method illustrated in Fig. 3. One side and one end of the die block were machined perfectly square and a center line drawn lengthwise on the face of the block. The location of the recesses was approximately laid out with lead pencil and the recess *A* bored in the lathe, by strapping the block to the faceplate. Before loosening the straps by which the block was held, the parallels, *B* and *C*, were strapped to the faceplate bearing against the finished edges of the block. The straps holding the block were then loosened and the block moved along the strip *C* sufficiently to allow for the insertion of the spacing block, *D*, which had previously been made of the required size. The die block was then fastened and the hole *E* recessed. By repeating this operation, and adding a block each time until all of the recesses were bored, it was possible to space the die far more accurately than would have been possible by the time-honored method of laying it out with dividers. The punch holder and the stripper were then bored in the same manner, using the same spacing blocks.

The bushings *F*, *G*, *H*, *I*, *J*, *K*, were next made, and after being hardened they were lapped to size. The outside of the bushing was ground concentric with the hole by wringing the bushing on a piece of soft steel held in the chuck and turned to fit the hole in the bushing. The bushings were then forced in the die block and the die was completed. The punches were ground all over, to insure straightness, and they, in turn, were forced into the punch holder. The drawing and forming punches *L* and *M* were held with setscrews to prevent them from pulling out.

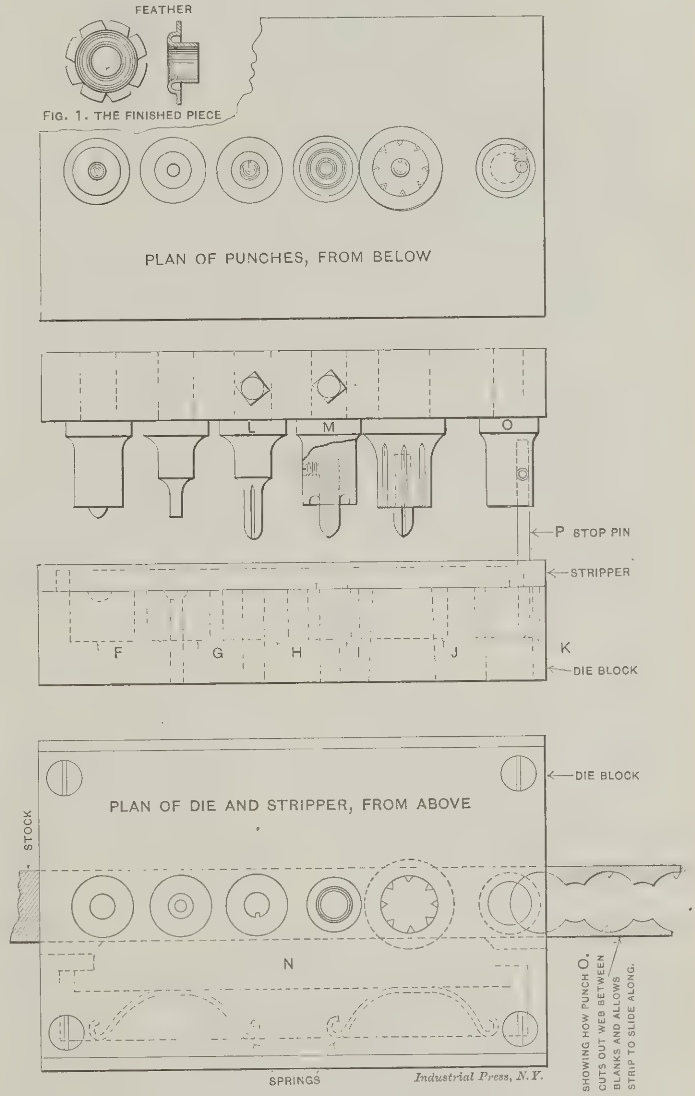
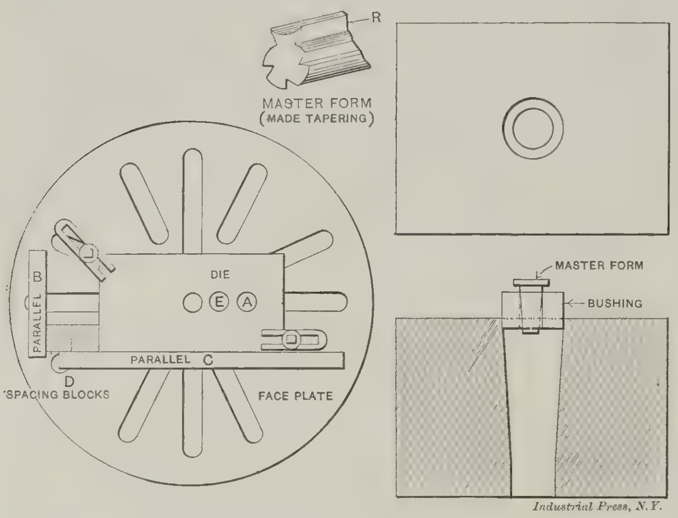

FEATHER
FIG. 1. THE FINISHED PIECE
PLAN OF PUNCHES, FROM BELOW
L
M
O
P STOP PIN
STRIPPER
F
G
H
I
J
K
DIE BLOCK
DIE BLOCK
PLAN OF DIE AND STRIPPER, FROM ABOVE
STOCK
N
SPRINGS
Industrial Press, N.Y.
SHOWING HOW PUNCH O CUTS OUT WEB BETWEEN BLANKS AND ALLOWS STRIP TO SLIDE ALONG.

Fig. 2. Punch and Die for making Pieces shown in Fig. 1.

In using a die containing two or more punches, considerable trouble is sometimes experienced on account of the variation in width of the stock to be punched. Should the stripper be planed to fit one of the strips of stock very nicely the chances are that the next strip would not enter the stripper at all. The part, *N*, shown in the plan of the die, is a novel and practical way in which this trouble is overcome. The stripper is planed out 1-16 inch wider than the stock and recessed to allow the spring guide *N* to slide freely when the stripper is in position in the die. By glancing at the sketch the reader can readily see how the springs keep the stock pressing against the gage side of the stripper. The punch *O* does not perform any work pertaining to the finished blank but is used for cutting out the web in the stock in order to allow the strip to move along until the next web touches the stop pin. As the stop pin *P* does not come out of the stock it is therefore impossible to "jump" the stock and make a miscut, which would mean disaster to the drawing and forming punches.

After "setting up" the die in the press, the punches of course descend five times before a single finished piece appears but thereafter a finished piece drops at each stroke of the press. The first punch, beginning at the left, indents the stock and the punch is so adjusted that the face of the punch levels the stock. The second punch pierces the bottom of the indentation. The next punch draws the stock and at the same time forms the feather shown in the finished piece. The fourth is the forming punch and the last punch does the blanking.

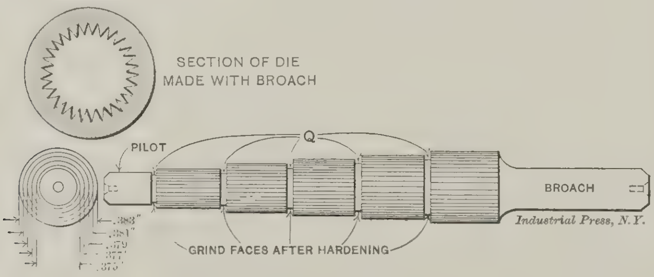


Industrial Press, N.Y.

Figs. 3 and 5. Die-making Kinks.

Fig. 4 shows a very good method of making a die that is to contain a number of identically-shaped teeth or points, such as dies for gear blanks, etc. While not being the most accurate method known, the writer considers that for all work intrusted to a punch and die the method illustrated will be sufficiently accurate. A set of broaches are made, as shown in the sketch, the number of steps being governed entirely by the length, or depth, of the teeth. The pilot fits the hole in the die, which is the diameter at the top of the teeth, and each step on the broach is .002 inch larger than the preceding step. The broaches are made on centers and necked in at *Q* to allow clearance for the chips. With a cutter of the proper shape the teeth are then milled on the broaches, using the dividing head on the miller. After cutting the teeth on all of the broaches the teeth on the punch should be cut at the same setting. The broach is then hardened and ground on the faces as indicated. In use each successive step is driven through the die until the last is reached, and this should be driven through as many times as there are teeth in the broach, turning it one tooth each time. By doing this whatever error may have been caused by hardening is overcome.

Fig. 5 shows a method for making very small, difficult-shaped dies, which are hard to duplicate when filed out by hand. First a master form is made, of the desired shape and tapering. This is carefully hardened. A hole is then drilled and reamed tapering, through a substantial block of tool steel, the block is hardened, and the hole lapped out perfectly smooth. A bushing of well annealed tool steel is then made, .005 inch smaller in diameter than the larger end of the tapered hole, and a hole drilled and reamed through it sufficiently large for the master form to just protrude through the lower end. The bushing containing the master form is then placed in the taper hole of the block and forced down by means of a hydraulic press. The stock is thus forced into the master form and dies made in this way can be easily duplicated when they are worn out.



Industrial Press, N.Y.

Fig. 4. Broach for Gear Blank Die.

Great Barrington, Mass. **Frank E. Shailor.**

GLOBULES OR SHAVINGS.

Editor Machinery:

The December issue of Machinery gives an account of tests of emery wheels and carborundum wheels at Sibley College, where they micro-photographed the metal removed by the wheels and found that from the emery wheel to be in the form of globules, and that from the carborundum wheel to be in the form of shavings.

I very much doubt if the experimenters had before them all of the conditions to warrant conclusions, for the writer certainly has looked through the microscope and has seen shavings from emery wheels; he has also seen globules from emery wheels. The difference was caused by different treatment and by the difference in grades and grains of the wheel for the particular material ground.

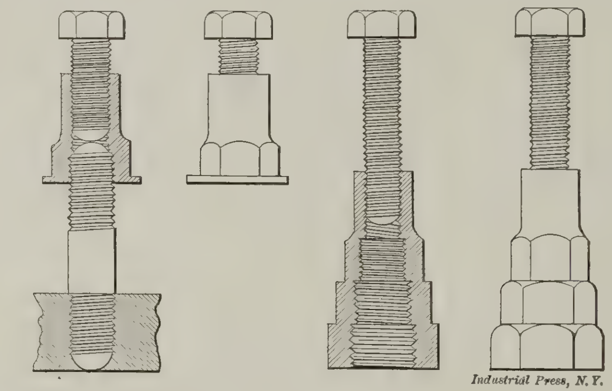
There are many things that enter in to change the results from all globules to part globules, and part shavings to all shavings. It is not so simple as would appear from the account. If the account is correct the experimenters have something to learn. **C. H. Norton.**

* * *

THE STUD-DRIVER PATENTED.

We must confess to some irritation of mind upon seeing in *Engineering's* illustrated weekly patent record that our old shop friend, the stud-driver, was recently patented (September 23, 1903) in Great Britain by Mr. E. Ravet, of London. Mr. Ravet has our sympathy. The description reads as follows:

"The object of this invention is to provide an improved appliance affixable to a screw stud, and whereby the stud can be easily screwed into place. The apparatus comprises a screw nut of greater depth than usual, and the screwed part thereof is preferably of two diameters, one diameter of screw-threaded hole encircling the stud, and the other for reception of a screw bolt, whose end engages the end of the stud, and on being tightened somewhat, tends to draw the nut toward it, and in so doing tightly clamps the nut to the screw thread of the stud, so that when the nut is operated by a spanner the stud will be turned without fear of slip. To release the appliance, all that is necessary is to turn back the lock-bolt, when the grip of the nut will be released, and the whole appliance be free to be removed by hand. The nut may have a tapering series of stud-holes of two, three, or more diameters, so as to be applicable for various sizes of studs."


Industrial Press, N.Y.

Recently Patented Stud Driver.

* * *

RE HISTORY JOHN STEPTOE SHAPER CO.

Editor Machinery:

In your article "Old Gear Cutter—History John Steptoe Shaper Co.," the Mr. Ed. Gang mentioned is Mr. William E. Gang, president of the William E. Gang Company. He is generally known among his friends and associates as "Ed." He is proud of the fact that he served his apprenticeship in John Steptoe's shop.

Arthur H. Gang,
Cincinnati, Ohio. Secretary William E. Gang Co.

* * *

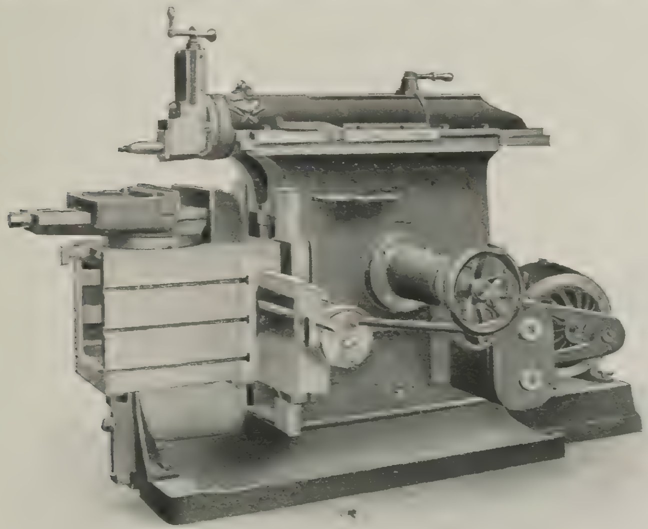
A plate mill has recently been erected at Coatesville, Pa., which is said to roll the widest plates made in this country. It will roll boiler plates 12 feet wide and up to ⅞-inch thickness. The rolls are 152 inches long.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

TWENTY-EIGHT INCH "AMERICAN" SHAPER WITH SPEED VARIATOR.

The 28-inch shaper illustrated in the half-tone herewith has just been placed on the market by the American Tool Works Co., Cincinnati, Ohio, and while the machine in general follows the design of their regular line of shapers, it has several new features, the principal of which is the speed variator, which takes the place of the cone pulley used with the ordinary type of machine. This shaper, as shown, is motor-driven and can be used with any type of motor, of constant or variable speed, single or multiple voltage. The motor is mounted at the rear on a base cast integral with that of the machine and may be connected to the speed variator by either gearing or flexible chain. The changes of speed are obtained through the variator, while the shaper is in full operation, by a clutch mechanism operated by conveniently-located levers, and the number of speeds thus obtained is doubled by means of the back gears. The necessary adjustment for speed is determined by reference to an index on the gear box.



Twenty-eight inch "American" Shaper with Speed Variator.

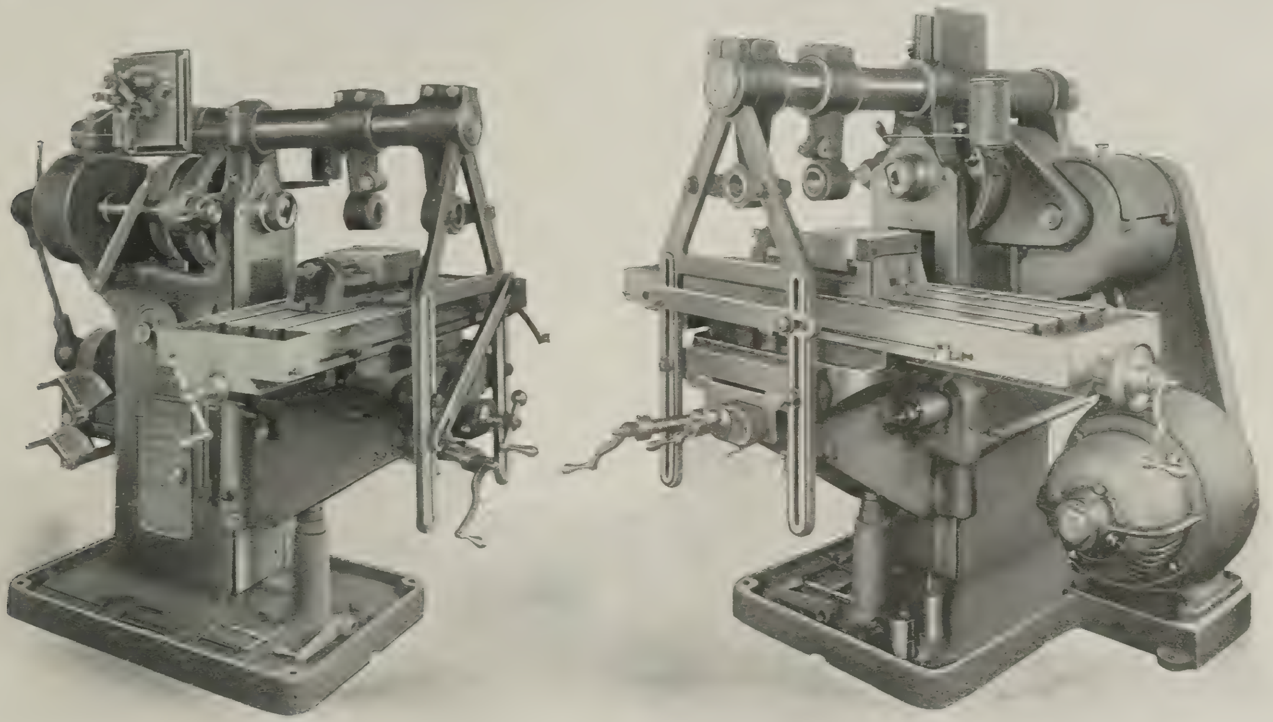


Fig 1. Cincinnati Milling Machine with Electric Motor Drive.

The stroke of the ram is positive and its length may be changed at will without stopping the machine. The rocker-arm is pivoted near the base line, giving the ram an almost uniform rate of speed throughout its entire stroke and providing a quick return. The cross feed is variable and automatic, with a wide range of feeds, and readily adjusts itself to any elevation of the rail. A reversal of the feeds is readily accomplished while the machine is in operation. This shaper is also suited to belt drive from a countershaft through a single pulley mounted on an extension of the upper shaft in the gear box, and the flexibility of this construction makes it a simple matter to equip a shaper that has been installed as a belt-driven machine, with motor drive at any time.

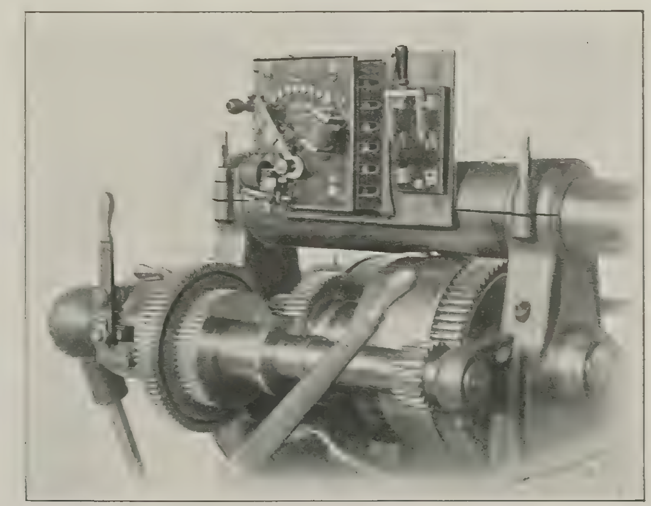


Fig. 2. Double Back Gears of Cincinnati Milling Machine.

ELECTRICALLY-DRIVEN MILLING MACHINE.

As the result of about four years' careful experiment and study of the problem of electric driving as applied to milling machines the Cincinnati Milling Machine Co., Cincinnati, Ohio, have just brought out the No. 4 plain miller with motor drive, that is illustrated in the photograph, Fig. 1. This machine is designed to be driven by a shunt-wound, direct-current motor operated by a field rheostat, the variations in speed being obtained from the motor and thus obviating the need of a nest of speed change gears. The right hand view of the machine shows how the motor is mounted on an extension cast onto the base. This brings it near the floor, thereby adding stability to the machine.

Any one of several well known makes of motors may be used provided it is shunt wound for a speed variation of 2½ to 1. This is multiplied by the double back gears so as to give a range of spindle speeds for cutters 5-16 to 6 inches in diameter of 20 feet per minute, and for cutters ⅝ to 12 inches in diameter of 40 feet per minute. Power is transmitted from the motor to a friction clutch and from thence to the spindle by Morse silent chains. This interposition of the friction clutch between the motor and the spindle is one of the novel features of the design. By its means the machine may be started and stopped quickly without stopping the motor, thereby saving considerable time that is otherwise lost in starting and waiting for the motor to stop.

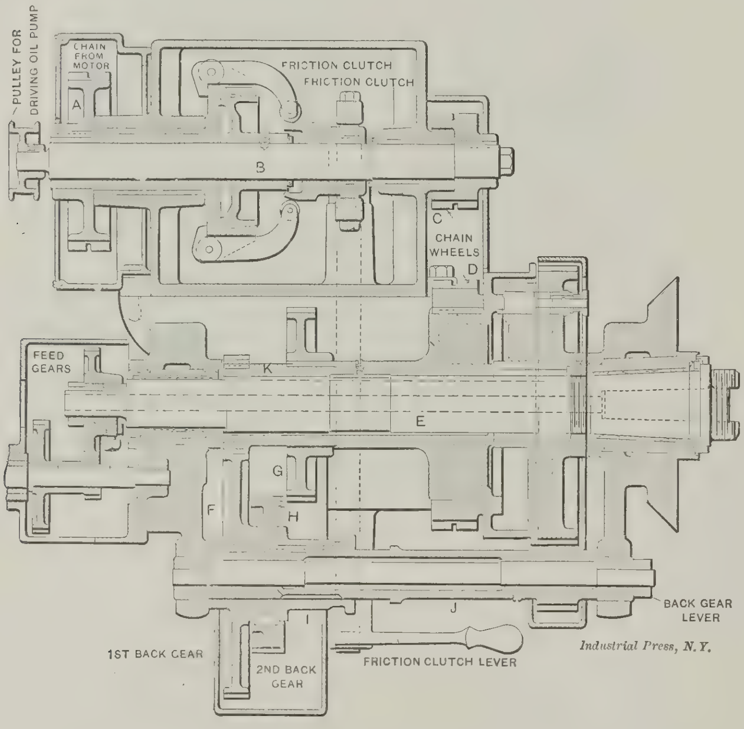
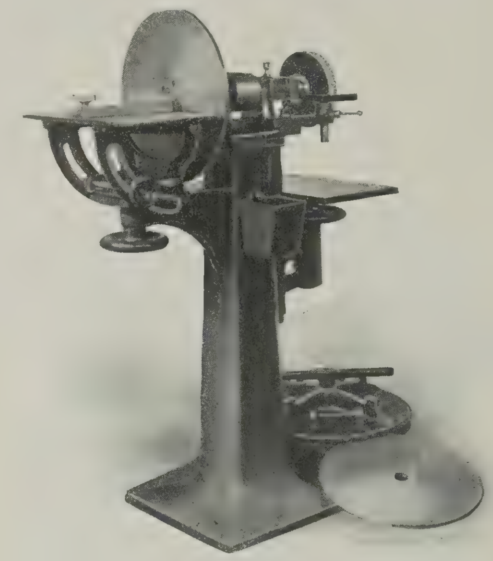


Fig. 3. Diagram of Driving Mechanism, Cincinnati Milling Machine.

The left hand view shows the arrangement of the automatic release, starting box, field rheostat, friction clutch lever, back gear lever, and double back gears, as well as the feed changing and adjusting levers, all of which are placed at the front of the machine, within easy reach of the operator, who need never go to the rear of the machine save for oiling it. Fig. 2 shows the arrangement of the double back gears, the details of construction of which are shown in the drawing, Fig. 3. The chain from the motor drives the wheel, *A*, which transmits power through shaft *B* and chain and chain wheels, *C* and *D*, to spindle, *E*. The back gears, *F* and *H*, are both geared to a sleeve, *I*, which slides on the back gear quill, *J*, and when used in the position shown, gear *F* is driven by the small gear on the main driving quill, *K*, giving the first series or slow back gear speeds. When it is desired to use the second back gears, the gears are thrown out of mesh in the usual way, the sleeve is moved along the back gear quill to bring *H* and *G* in line and the gears thrown in again.

SANDING MACHINE AND TOOL GRINDER.

A machine designed especially for the use of patternmakers and woodworkers is the combination sanding machine and tool grinder which is illustrated herewith. On the left-hand end of the spindle is mounted a steel disk 16 inches in diameter, which is covered with sandpaper on both sides and is easily reversed. This is used for sanding surfaces at right angles, or at any angle with the plane of the disk, and is very serviceable for turning bosses, core prints, etc., either straight or tapered, which can be done in the time usually required to set up such work in a lathe. A spare disk is also provided so that no time need be lost, as one disk can be prepared while the other is in use. The sandpaper is attached to the disks, under pressure, in a press that accompanies the machine.



Combined Sanding Machine and Tool Grinder.

The work table, which is counterbalanced, is released, raised or lowered, adjusted to approximate position, and fastened by one lever and then by a hand wheel under the table, a fine adjustment or screw feed is provided. This table will lock at a right angle to the disk, or will adjust to any angle, and is furnished with a gage adjusted to any angle on the horizontal plane.

On the right-hand end of the spindle is placed an emery wheel for tool grinding and, by changing wheels, all shapes of tools, gouges and carving tools can be ground inside and outside. Under this wheel is a table for surface grinding, which is very handy for use on metal patterns and work of a similar nature. The bearings, which are babbitted and dustproof, are provided with an adjustment for wear. This machine is the product of the Rowbottom Machine Co., Inc., Waterbury, Conn.

THE "IDEAL" ENGINE LATHE WITH MOTOR DRIVE.

The photograph shown in Fig. 1 illustrates the method by which the Springfield Machine Tool Company, Springfield, Ohio,

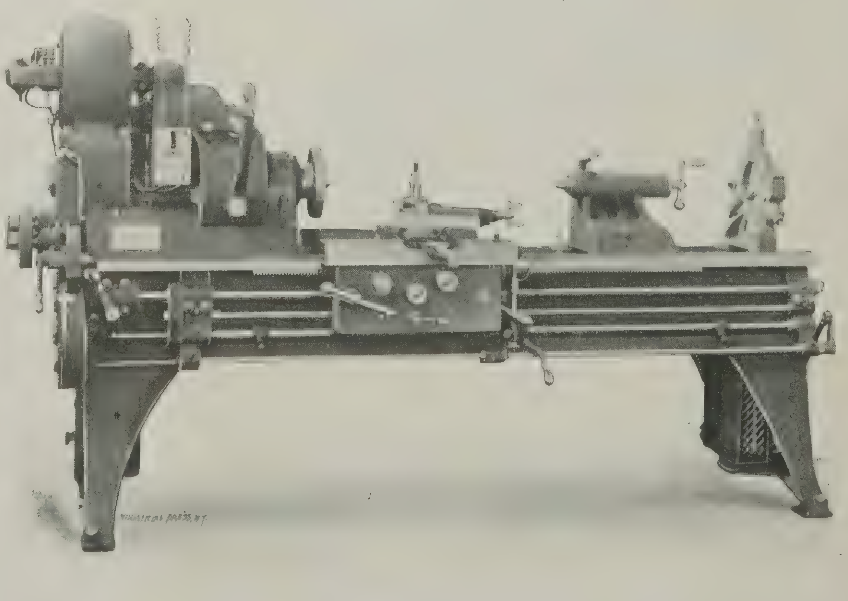


Fig. 1. "Ideal" Engine Lathe with Motor Drive.

have equipped their 18-inch "Ideal" engine lathe for the use of motor drive. As will be seen in the illustration, this lathe has been completely redesigned as a motor tool so that, instead of bolting a motor-bracket to the headstock, projections for carrying the motor and also bearings for the extra shaft are cast integral with the headstock. The details of the driving mechanism are clearly shown in the line drawing, Fig. 2, which represents a section through the headstock. A pinion on the motor shaft engages a gear on the extra shaft which is mounted directly over the lathe spindle. On this shaft are placed a pair of gears which may be slipped into mesh with either of the gears which take the place of the usual cone pulley. In connection with the back gears, which are thrown in and out by means of a pair of friction clutches, four mechanical changes of speed are obtained, and these, with the 100 per cent. of speed variation of the motor, provide for a wide range of speeds.

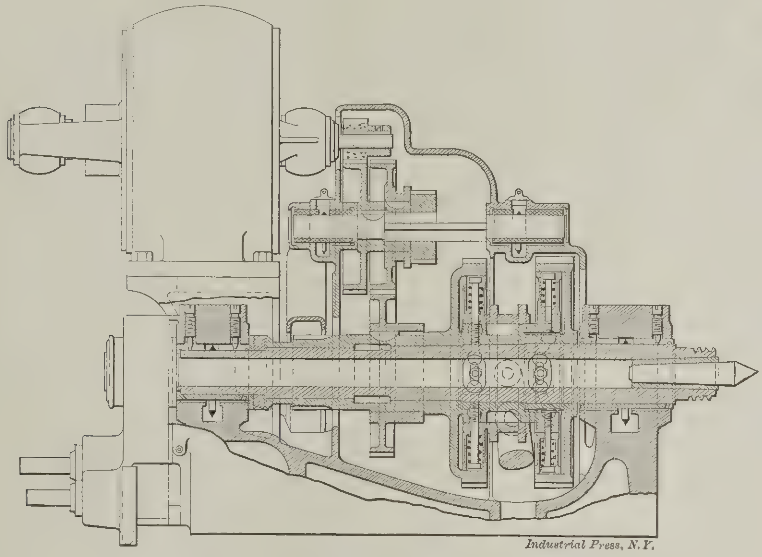
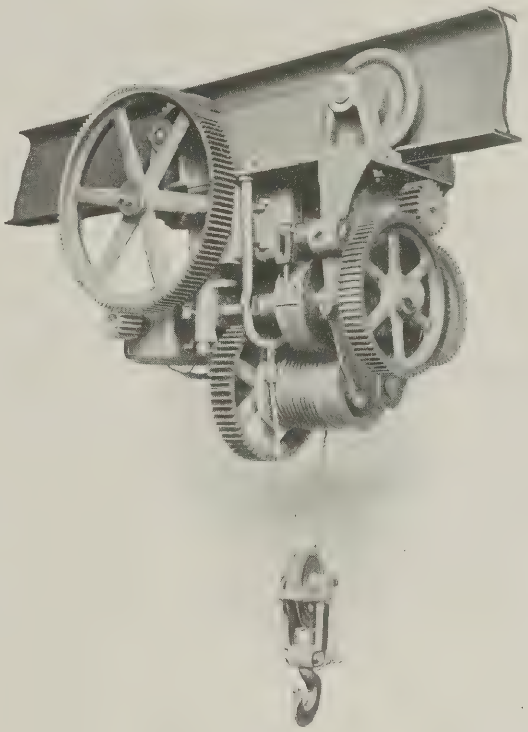

Industrial Press, N.Y.

Fig. 2. Section through Head of "Ideal" Lathe.

The motor employed is a 1½ horse power machine built by the Northern Electric Manufacturing Company, Madison, Wis., and runs at a normal speed of 600 revolutions per minute, which may be increased to 1,200 revolutions by weakening the fields. The speed of the motor is regulated by a Cutler-Hammer controller, which is bolted to the inner side of the rear leg of the lathe, where it is protected from injury yet easily accessible if repairs are necessary. The rod by which the controller is operated is supported in extensions to the leadscrew box, while a handle at the right-hand side of the carriage operates the controller rod by the means of miter gears. In other respects this lathe embodies all of the principal features of the "Ideal" lathe as built by the company.

ELECTRIC TROLLEY HOISTS.

The use of small cranes or hoists, running on overhead I-beams, has widely extended in machine shops and at present the majority of heavy tools are provided with some type of hoist for quickly and easily handling the work on and off from the machine. These hoists may be operated by hand, steam, compressed air, or electricity, the latter power having proved very satisfactory and convenient since it does away with all the piping that is involved by the use of air or steam. A new line of this type of hoist, operated by electricity has just been brought out by the Northern Engineering Works, Detroit, Mich., and one of them is illustrated herewith. This hoist is of the two-motor type and has a capacity of 3 tons. It is spur-geared throughout and has a hoisting speed of from 10 to 25 feet per minute, the hoist being operated by a 3 horse power motor. The travel movement is operated by a separate motor of 2 horse power capacity which is capable of giving a travel speed of about 200 feet per minute. Two automatic brakes are provided, one mechanical and one electrical, and a safety stop prevents the block from running into the trolley. This hoist can be made to run on any size of I-beam or on two beams if preferred, and it may be modified so that it will run around curves if desired. These hoists are made in capacities of 2, 3 and 5 tons, and the motors may be wound to run on 110, 220 or 500 volts, direct current. The motors are of the enclosed type and are adapted for use in the presence of considerable dust and dirt and when so used the gears are provided with casings.



Electric Trolley Hoist.

POSITIVE SELF FEED FOR THE DRILL PRESS.

The W. F. & John Barnes Co., Rockford, Ill., have just adopted for use on their entire line of upright drills a new positive self-feeding mechanism which is a radical departure from anything yet produced for this purpose. Fig. 1 shows one of the drills thus equipped and Fig. 2 is a detail of the feeding mechanism, showing the back gearing and the feed-changing device. The vertical feed rod is driven from a feed disk having four series of teeth, with any one of which the

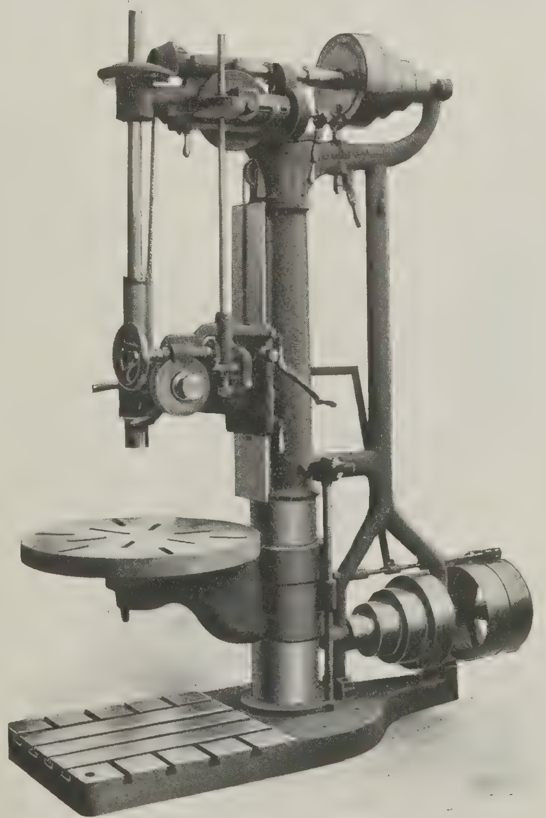


Fig. 1. Barnes Drill with Positive Feed Device.

driving pinion on the horizontal shaft may be engaged. A notched lever is employed to move this pinion and to lock it in position and when this lever is raised the pinion may be moved from the position shown in the illustration to engagement with any other set of teeth in the disk. This provides for four changes of feed and, with the back gearing used on the larger sizes of drills, eight changes of feed may be obtained, and these changes may be made while the drill is in operation, thus avoiding the delay of stopping the machine for throwing in or out of belts. These feeds are arranged to vary from one adapted to reamer work, or one for drilling in steel, to one of suitable coarseness for boring in cast iron. The wide variation of feeds also fits these drills for use with both the regular grades of steel and with the high-speed steels that are now being used very extensively.

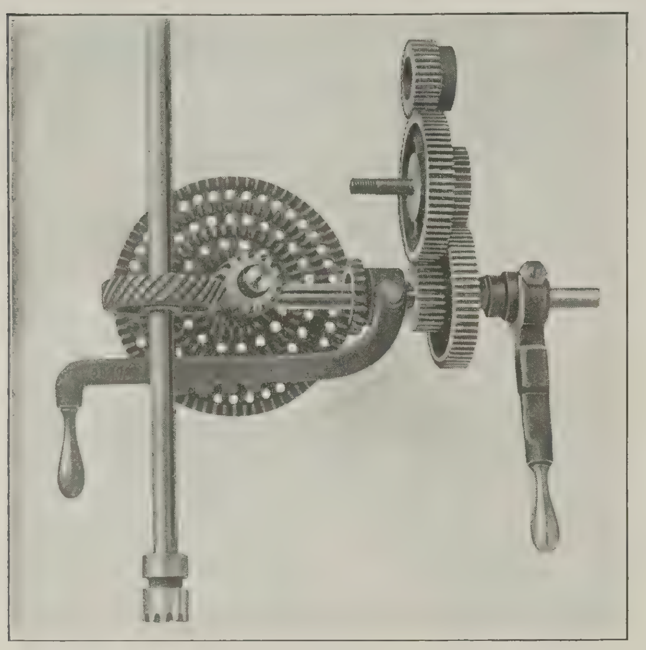
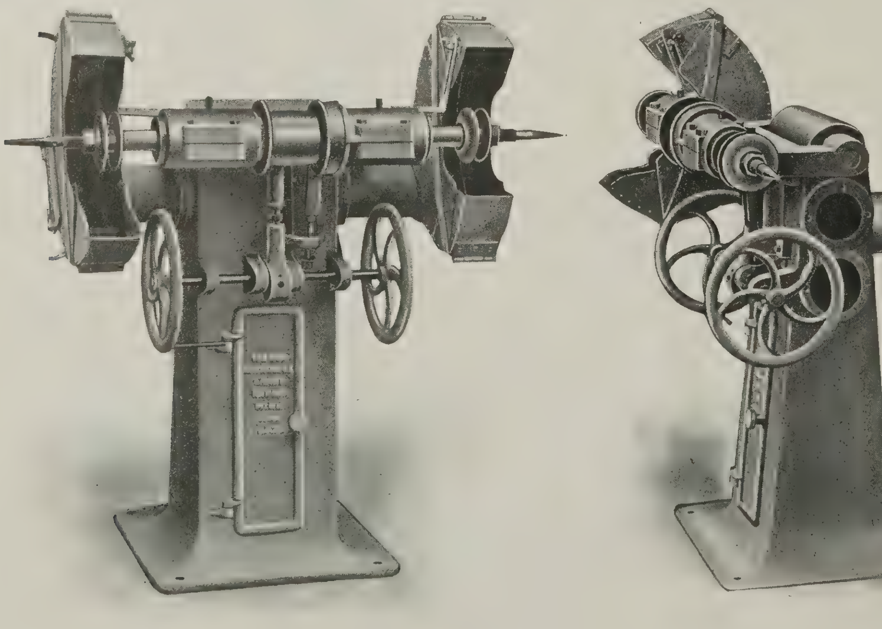


Fig. 2. Positive Feed Device used on Barnes Drills.

DOUBLE POLISHING STAND.



Double Polishing Stand.

The Fox Machine Co., Grand Rapids, Mich., have just brought out a new polishing stand embodying several novel and very convenient features that fit it for rapid work and clean service. The polishing spindle of this machine, instead of being carried directly by the column, is supported in a swinging yoke which is pivoted about the top of the column, as will be clearly seen in the end view of the machine. This yoke is connected, through a right- and left-hand connection, to an eccentric shaft journaled in brackets on the face of the column. On either end of this shaft is placed a large hand wheel so that the polisher may be started or stopped by either operator from his position in front of the machine. A partial turn of either of these wheels in one direction tightens the belt and causes the spindle to rotate, while if the wheel is turned in the other direction the arm is raised and the belt thereby loosened while at the same time a brake is automatically brought into action so that the machine is instantly stopped.

These polishers are designed for use with an exhaust system and for this purpose both of the wheels are covered with dust hoods or collectors, which have exhaust connection with the hollow column. The columns themselves may be connected with the exhaust system either from the back or down through the column and the floor. By this system all of the dust and dirt of polishing is immediately removed, a feature which is especially valuable where gold and silver are being polished, as in jewelry shops, where the dust is conducted to a precipitating tank and all of the valuable metal recovered. The hoods may be adjusted to accommodate different sizes of wheels from the maximum of 14 inches in diameter down, and they are bolted to the column in such a manner that they may be readily detached if desired. The arbor runs in roller bearings which are thoroughly protected from dust and dirt. No special countershaft is required, as the yoke acts as a belt tightener and the flanges of the pulley prevent the belt from running off. The machine complete weighs about 450 pounds.

ELECTRICALLY-DRIVEN TOOL ROOM DRILL.

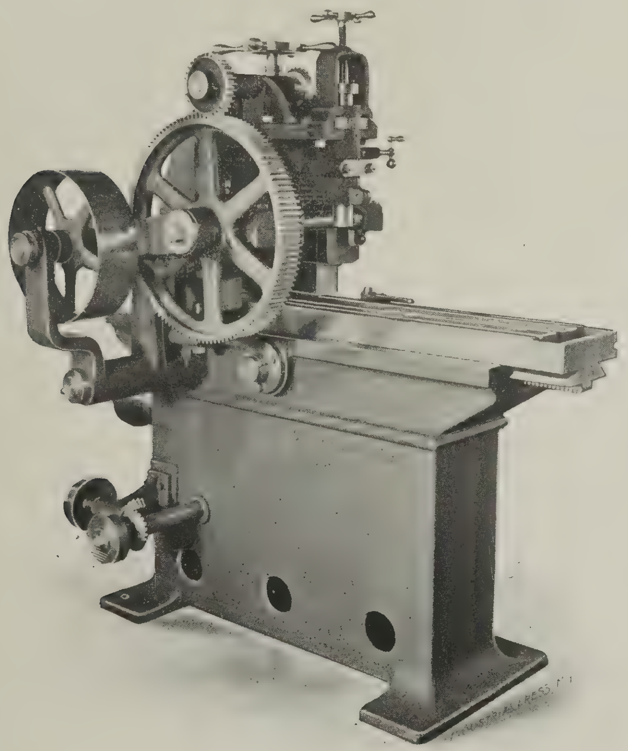
An application of electric drive to small drills has lately been brought out in the form illustrated herewith, which is a tool room drill built by the Dwight Slate Machine Co., Hartford, Conn., to the spindle of which is directly connected a one-quarter horse power motor made by the Emerson Electric Mfg. Co., St. Louis, Mo. Owing to the specially compounded and series field, the motor employed is connected directly from line to binding posts without starting box, being started and stopped from a small two-pole snap switch within convenient reach of the operator. The rush of starting current is cared for by the speed regulating coils of the motor itself, and the proportions of this field are such that if the motor should be stopped entirely by the drill sticking in the work, or by the use of too large a drill, no damage to the motor would result. This special winding also enables

Electric Tool Room Drill.

the motor to automatically adjust its speed to the size of the drill in the chuck and the material being drilled, this regulation being obtained by the motor itself entirely automatically. The motor furnished will handle work up to the full capacity of the drill press, being capable of running a ⅝-inch drill in cast iron, but it is not recommended for drills much over 5-16 inch for general use. This machine may be placed and operated anywhere that a 110 or 220-volt direct current is available.

KEYSEAT MILLING MACHINE.

The accompanying half-tone illustrates a new keyseat milling machine that has just been placed upon the market by John T. Burr & Son, Brooklyn, N. Y., which is designed for keyseating shafts up to 6 inches in diameter, and which has an extreme capacity through the housings for work up to 10⅜ by 9⅜ inches. The platen, provided with three T-slots, oil channels and pockets, has an automatic feed of 48 inches with automatic adjustable tripping device. The spindle is designed for cutters with 1½-inch standard hole, up to 5 inches in diameter, and this spindle has an adjustment allowing it to work at a distance of 1⅛ inches above the platen up to a maximum height of 11½ inches. The friction countershaft provides for two changes of spindle speed and there are twelve changes of feed for each spindle speed.

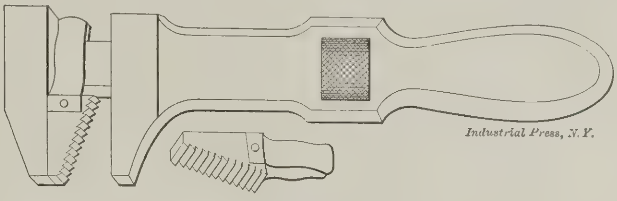


Keyseat Milling Machine.

Connected with the main driving gears is a chain of gearing by means of which an independent routing spindle is operated. This spindle has an independent vertical adjustment of 3¼ inches and a horizontal movement of 3⅛ inches, while, in connection with the saddle movement, it may be used at a height from the face of the platen up to 13⅜ inches above it. An oil pump with flexible connections is provided for the use of lubricant with the cutters. This machine complete, as shown, weighs about 3,200 pounds, and it may be furnished without the routing spindle if desired.

PIPE ATTACHMENT FOR WRENCH.

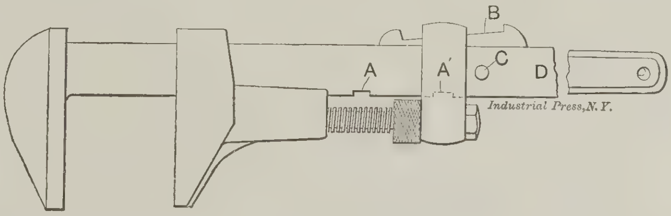
The Billings & Spencer Company, Hartford, Conn., have just placed upon the market an attachment for use with their 6- and 8-inch adjustable wrenches, by means of which the ordinary wrench is immediately converted into a pipe wrench. This attachment consists of the small removable pipe jaw which is shown in the cut both in position on the wrench and also as it appears when it is removed. This jaw is made of steel, provided with a toothed face for gripping the pipe and is held in place by two side springs which allow it to be put in place or removed without any trouble or the need of any tools. By simply reversing its position on the wrench, it is fitted for either right or left hand use. The wrenches, when supplied with this attachment, are suited for use on pipe up to and including ¾-inch.



Adjustable Wrench with Pipe Attachment.

IMPROVED MONKEY WRENCH FOR LARGE NUTS.

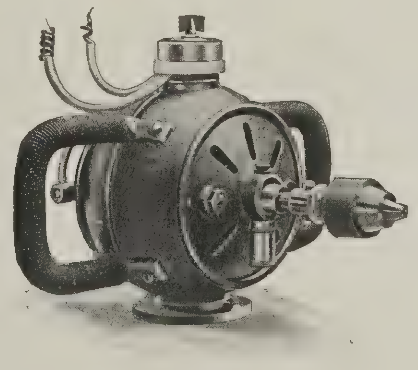
That indefatigable inventor and improver of the monkey wrench, Mr. Loring Coes, evidently has again been engaged in his favorite amusement, since the Coes Wrench Company have recently brought out an improved form of this useful tool, designed to be of greater service in heavy work. The new style, shown in the accompanying cut, is made in two sizes, viz.: 26-inch and 30-inch for nuts up to 5 and 6 inches respectively. The improvement consists of making the handle in the shape of a flat iron bar and notching it in two places, *A* and *A'*, for the reception of a projection on the inside of the strap next the bolster. Obviously the strap is placed in position *A* for the smaller nuts and at *A'* for the larger ones, this device doing away with an excessively long screw. In either position the strap is firmly held by the double-headed key *B*. A pin *C* through the handle *D* prevents the strap sliding off when the change is being made.



Monkey Wrench for Large Nuts.

SMALL PORTABLE ELECTRIC DRILL.

The Sprague Electric Company, New York City, have just placed on the market two sizes of the small portable drill that is shown in the accompanying illustration. This type of drill will be found very handy for all kinds of shop drilling which is now performed with the breast drill, and saves much time and labor in the erection of machinery where small holes, such as oil and pin holes, are drilled after the machines are assembled. A small round type of motor is employed, which is suited for use on a 115 or 230-volt direct current, and two substantial handles are attached to its sides to hold it while in use. The motor shaft is fitted with a standard adjustable chuck for any size of drill up to and including 5-16 inch. The two sizes that are now being furnished are of a capacity of 1-20 and 1-10 horse power respectively.



Portable Electric Drill.

NEW TRADE LITERATURE.

The Stow Flexible Shaft Company, Philadelphia, Pa. Circular calling attention to the portable drills of the company's manufacture. Several varieties of these are here shown.

The William E. Gang Company, Cincinnati, O. Pamphlet illustrating and describing the radial drill manufactured by this company. This was illustrated in Machinery some time ago.

The Buffalo Forge Company, Buffalo, N. Y. Two new circulars relative to the "Buffalo" disk wheels and "Buffalo" improved ventilators. These are illustrated, and the two named products are described quite at length.

The Northern Electrical Manufacturing Company, Madison, Wis. Bulletin No. 34 illustrating their motors for operating valves. These motors are built for operating large sluice and gate valves, and are here fully described.

The Carlyle Johnson Machine Company, Hartford, Conn. "Booklet C," treating of the Johnson friction clutches for machines, gas engines, countershafts. Also circulars illustrating and describing their No. 4 and No. 6 single clutch.

The Binsse Machine Company, Newark, N. J. Catalogue and Treatise No. 3, 1904. This illustrates the "Binsse" horizontal boring machine, sizes 1, 3, 5 and 9, and gives brief descriptions and fine half-tone views of its various features and of work done.

The Kempsmith Manufacturing Company, Milwaukee, Wis. Advertising card illustrating their No. 24 universal miller, among whose features are automatic feeds in all directions; feed reverse at front of knee; telescopic vertical screw and deep and broad column.

The Newton Machine Tool Works, Inc., Philadelphia, Pa. Catalogue No. 37, of rotary planers. These are built in eleven sizes, with heads from 14 inches to 84 inches in diameter over tools, and several styles are shown such as the rotary planer on round base, the portable rotary planer, duplex rotary planer, vertical rotary planer, etc.

The Armstrong Brothers Tool Company, Chicago, Ill. Catalogue No. 10, of tool holders and machine shop specialties. The new goods added to their regular line are: A drop head tool holder; left-hand offset cutting-off tool; side tools; a slotter tool; a universal ratchet drill; and a machine for cutting off self-hardening steel.

The Woodward & Powell Planer Company, Worcester, Mass. Catalogue B4, of metal planing machines. This illustrates the company's planers, 22 to 120 inches; widened planers from 36 by 30 inches to 76 by 48 inches; and special planers, for work on globe valves, frog crossings, locomotive rods, etc. Several half-tone views show the works at Worcester, and interior views of the business offices, the various departments, etc.

The Fosdick Machine Tool Company, Cincinnati, O. Handsomely illustrated folder treating of the new Fosdick horizontal, boring, drilling and milling machine. A general description of this machine appears, and excellent photographic reproductions showing the operations of boring, drilling and milling, also cuts reproducing the working drawings of the plan, side elevation and front elevation of the machine.

The Northern Engineering Works, Detroit, Mich. Catalogue No. 18, of electric and hand power traveling cranes. This supplements the company's general crane catalogue and illustrates their cranes for pumping stations, power stations for electric railways, large industrial plants and lighting stations. Besides these they also manufacture cranes for foundries, machine shops, etc. A number of views show these cranes installed in different shops.

The Curtis & Co. Mfg. Co., St. Louis, Mo. Illustrated catalogue, 1904, of pneumatic machinery. This includes air compressors, air hoists and pneumatic appliances. The "Curtis" automatic compressor, belt-diven and electrically-driven is shown by half-tones and line drawings; and air hoists of different sizes and styles for many and various purposes. Also "Curtis" single and double I-beam traveling cranes and trolleys and other hoisting apparatus. A number of views show these hoists, cranes and trolleys installed in foundries, shops, etc.

The Bradford Machine Tool Company, Cincinnati, O. Illustrated catalogue, standard size, of the "Bradford" lathes. This is an attractive piece of advertising literature, containing handsome half-tone illustrations, printed on heavy coated paper, showing the different sizes of lathes, and its notable features, such as the spindle and its mountings; spindle bearings; lathe apron; improved taper-turning attachment; lathe parts; turning tools; chucks; screw-cutting attachment; the driving and feeding arrangement for their 36 and 42-inch lathes, etc.

The Bullock Electric Manufacturing Company, Cincinnati, O., inform us that their Shop No. 2 of their plant, containing punch presses, annealing ovens and forges, was recently partially destroyed by fire. Their tools are not seriously damaged, however, and they have erected temporary sheds over them, so that there will be no delay whatever in completion of orders they have on hand or of any they may receive. Shop No. 2 will be immediately reconstructed and on a larger scale than originally planned.

The F. B. Shuster Company, New Haven, Conn. New illustrated catalogue of straightening, cutting and riveting machinery. This includes automatic wire-straighteners and cutters; slide feed, automatic wire-straighteners and cutters; roll wire-straighteners; self-feeding roll wire-straighteners; geared roll straightener and cutter; rotary straighteners; elastic rotary-blow riveting machines; double-head riveting machines, etc. Views of these machines are shown, and samples of the work done. The company will be pleased to supply this new catalogue on request.

The Brown & Sharpe Manufacturing Company, Providence, R. I. Latest edition of the company's machinists' tool catalogue. Here are illustrated and described their regular line of machinists' tools; and a colored insert calls attention to the various new tools that have been added during the past year, among which is the new clamping device for their micrometer caliper, which they inform us is entirely new in design and much superior to the old-style clamp nut. The catalogue contains 153 pages, some of which are devoted to tables and other data of convenience to the machinist.

The Hyatt Roller Bearing Company, Harrison, N. J. Bulletin Twenty, of the Hyatt flexible roller bearings. This roller is here thoroughly treated, illustrations being given showing its application to shafting, traveling cranes, transfer cars, trolleys, hoists, etc. The advantages claimed for these bearings are durability, practicability, simplicity, efficiency, low cost, oiling facilities, and the fact that they have been thoroughly tested and have proved successful. The company refer those desiring further information upon this subject to an account of a series of exhaustive tests of these bearings conducted by the Franklin Institute and published in their Journal, February, 1899.

American School of Correspondence, Armour Institute, Chicago, Ill. Folder relative to the "Cyclopedia of Engineering." This is a compilation of the most practical and instructive papers of the School, intended to furnish actual instruction to those who cannot take a correspondence course. It has been carefully prepared with a view to meeting actual shop needs and conditions. It consists of four volumes and comprises 2,500 pages, illustrated with 1,500 colored plates, diagrams, tables, formulas, etc., and treats of mechanical, electrical, stationary, marine and locomotive engineering, etc. The folder gives an outline of the contents of this work, which is edited by Prof. Louis Derr, of Massachusetts Institute of Technology.

The Charter Gas Engine Co., 9-11 Wallace St., Sterling, Ill. Catalogue P, just issued, of the "Charter" gas and gasoline engines. The special features of this engine are here described and illustrated. and the different styles of horizontal engines, for a great varity of purposes, and built in sizes of from 4 to 40 H. P. are shown. A 1½ H. P. vertical "Charter" engine appears, also cuts and description of the "Sterling" portable gasoline engine of from 8 to 25 H. P. capacity. Several circulars have likewise been received from the Charter Gas Engine Co., containing testimonial letters from a very large number of firms in every line of trade in which these engines may be used, speaking in very favorable terms of the "Charter" engines.

Hammacher, Schlemmer & Co., New York. Booklet entitled "Fifty-five Years at It," calling attention to the large line of articles the company manufacture, and to the fact that they issue yearly 3,000 pages of catalogue matter pertaining to this line. This literature is supplied gratuitously to manufacturers having worthy commercial ratings, and on fair terms, to individuals desiring same. Those having no printed letter head are requested to announce what their requirements are. Mention is made of Catalogues No. 180, presenting 908 pages concerning tools; No. 114, relative to bolts, screws, nuts and supplies; No. 145, builders' hardware; No. 151, cabinet hardware; No. 192, fancy cabinet trimmings; No. 170, tool outfits for home use, etc.

MANUFACTURERS' NOTES.

Maris Bros., makers of hand and electric power cranes, Philadelphia, Pa., are building a 30-foot addition to their works. They report business as good.

The Cochrane-Bly Machine Works, Rochester, N. Y., have recently moved into their new factory, corner of Sherman Street and St. James Park. The new shop is very substantially built and is 40 feet by 200.

The Howard Iron Works, Buffalo, N. Y., manufacturers of elevators, vises, bolt machinery and power transmission machinery, inform us that they are just completing a new and large modern foundry, with all the improved equipment necessary.

The J. W. Cregar Agency, The Bourse, Philadelphia, Pa., have been made purchasing agent for the Limon and Agricola Mines, near Jalapa, Nicaragua, Central America, and would be glad to have manufacturers send their catalogues and export trade prices on everything used in mines and sold in mining companies' stores.

The Homestead Valve Manufacturing Company, Pittsburg, Pa., announce that in conjunction with their brass foundry they have installed a complete iron foundry for the production of brass and iron. They inform us that through their method of using a conversion furnace in which heavy blast is used, they obtain a very pure metal, which enables them to make a superior semi-steel valve.

The Derry-Collard Company, 256 Broadway, New York, are publishing a series of "Monographs on Popular Technical Subjects." We have already noticed in these columns the two booklets treating of Turning Tapers and of the Drafting of Cams. Two more have since appeared: Commutators, and Threads and Thread Cutting, and others are in course of preparation. The price of each monograph is 25 cents.

The Hartford Blower Company, Hartford, Conn., have received an order for furnishing exhaust systems for the buffing and plating departments of the N. Y., N. H. & H. R. R. Co., at their new shops at Readville, Mass. The apparatus consists of two special, direct-connected, motor-driven "Hartford" adjustable exhaust fans, "Hartford" patent improved dust collectors, galvanized sheet steel piping, hoods, etc., with many new special fittings and attachments.

The Cling-Surface Manufacturing Company, Buffalo, N. Y., have sent us a duplicate of a letter they recently received from the Norcross Brownstone Company in regard to their Cling-Surface preparation. It speaks most favorably of Cling-Surface and says, among other things: "We are perfectly satisfied with what it (Cling-Surface) has done and our intention is, when we put on another rope, to give it a thorough application of your Cling-Surface before the rope is put on."

The Hartford Blower Company, 120 Suffield Street, Hartford, Conn., have gone to press with a new catalogue, No. 56, entitled "The Hartford Blowers and Exhaust Fans," which illustrates and describes the well-known Hartford patent improved adjustable blowers and exhaust fans, steel plate steam and pulley fans, disk fans, countershafts, blast gates, dust collectors, etc. The Hartford Company make a specialty of installing heating, ventilating, and mechanical draft apparatus, and announce that they will be pleased to send one of these new catalogues, free of charge, to any one interested.

The National Twist Drill and Tool Company, Detroit, Mich., announce the completion of their factory for the manufacture of reamers, cutters and all kinds of special tools. This has been equipped with modern machinery and an improved tempering process. They state that only high-class workmen are employed, and the most careful selection of steel made, with the object of placing on the market a product of superior quality. All their tools will be subjected to careful inspection and micrometer test. Mr. P. J. Hoenschied, their manager and superintendent, has had 22 years' experience in this line.

The Wilmarth & Morman Company, Grand Rapids, Mich., announce among their shipments of the "New Yankee" drill grinders in November, the following: Geometric Drill Company, New Haven, Conn.; English Iron Works Company, Kansas City, Mo.; Bridgeport Machine and Motor Company, Bridgeport, Conn.; Hydro-Carbon Light Company, Wichita, Kan.; Ideal Manufacturing Company, New Haven, Conn.; Fairfield Motor Company, Bridgeport, Conn.; Omega Steel Company, New Haven, Conn.; Homer D. Bronson Company, Beacon Falls, Conn.; North Penn Iron Company, Philadelphia, Pa.; Dodge Bros., Detroit, Mich.; Springfield Boiler and Manufacturing Company, Springfield, Ill.; New Jersey Zinc Company, Hazard, Pa.; Manning, Maxwell & Moore, New York; also seven drill grinders to England, and one to South America.

The Detroit Lubricator Company, Detroit, Mich., inform us that the Circuit Court for Wayne County, State of Michigan, issued an injunction on November 17 in their favor against the Michigan Lubricator Company, restraining them from using the words "Detroit Lubricators," "Improved Standard Lubricators," "Detroit Improved Standard Lubricators," in connection with their lubricators or advertising matter; also restraining them from using boxes or packages for their lubricators bearing the words "Detroit" or "Detroit, Mich.," unless their firm name be also given. For some time past the Michigan Lubricator Company have been making lubricators resembling those made by the Detroit Lubricator Company in outward appearance, and they have stamped on these lubricators and on the boxes containing them only the words, "Detroit, Mich.," making no mention of their firm name, the object evidently being to have such lubricators substituted for the genuine Detroit lubricators. In order to prevent their customers from being deceived and imposed upon by such tactics the Detroit Lubricator Company asked for this injunction, which was at once granted.

MACHINERY.

February, 1904.

SHOP NO. 3 OF THE BULLOCK ELECTRIC MFG. COMPANY.

THE works of the Bullock Electric Mfg. Co., although nominally in Cincinnati, Ohio, are really in the outskirts, in the pleasant suburb of South Norwood. The buildings constituting the works are of unusually attractive appearance (for a manufacturing plant), being built of buff pressed brick, with well-kept grounds. A recent addition, with which this description has to deal, is the heavy machine and erecting shop No. 3, or rather that part which was completed during the past year. A general view of the west end of shop No. 3 and of the service building, appears in Fig. 1. As intimated the new shop is not yet completed, the plan being to extend it 300 feet further east, but since the addition will be in harmony with the completed section, a description of the latter will largely apply to the whole structure.

Shop No. 3 was erected for building heavy generators and rotary converters—the former in the largest sizes up to 10,000 K. W. if demanded. The section shown in the plan view, Fig. 2. is 175 feet wide and 200 feet long. The east wall is a temporary wooden structure which will be torn down when the extension is built. The middle bay, as shown in the views, Figs 3, 4 and 5, is very high and wide. The width is 77 feet 10½ inches and the clearance beneath the hook of the 50-ton traveling crane is 50 feet. The north bay is 48 feet 9¼ inches wide and is served by a traveling crane of 30 tons capacity. The south bay is of the same width and is served by a 20-ton crane. Both cranes in the side bays have a lift of 26 feet. The roof is of the monitor type, with four skylights and windows in the sides of the monitor. Fully 50 per cent. of the side walls and of the permanent west end wall below the gable is glass. The sides of the monitor are practically all glass, and the skylights of translucent fiber that pierce both slopes of the monitor roof and each slope over the side bays, are continuous from one end of the shop to the other. The result is that a vast flood of light is admitted from all directions, leaving little to be desired in this respect. A valuable feature of the translucent fiber skylight is that it is not affected or broken by severe hailstorms or the vibration of the building, but its chief advantage is that the light admitted is softened and subdued, which is particularly agreeable in summer.

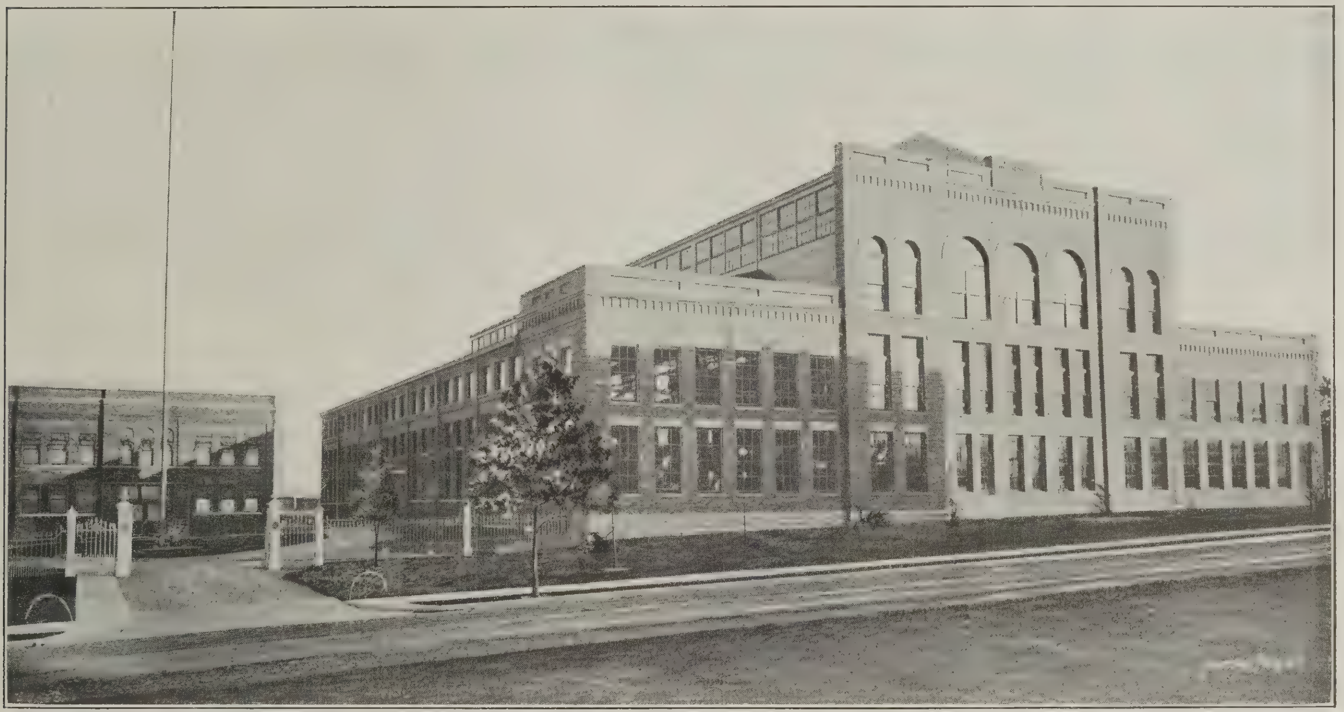
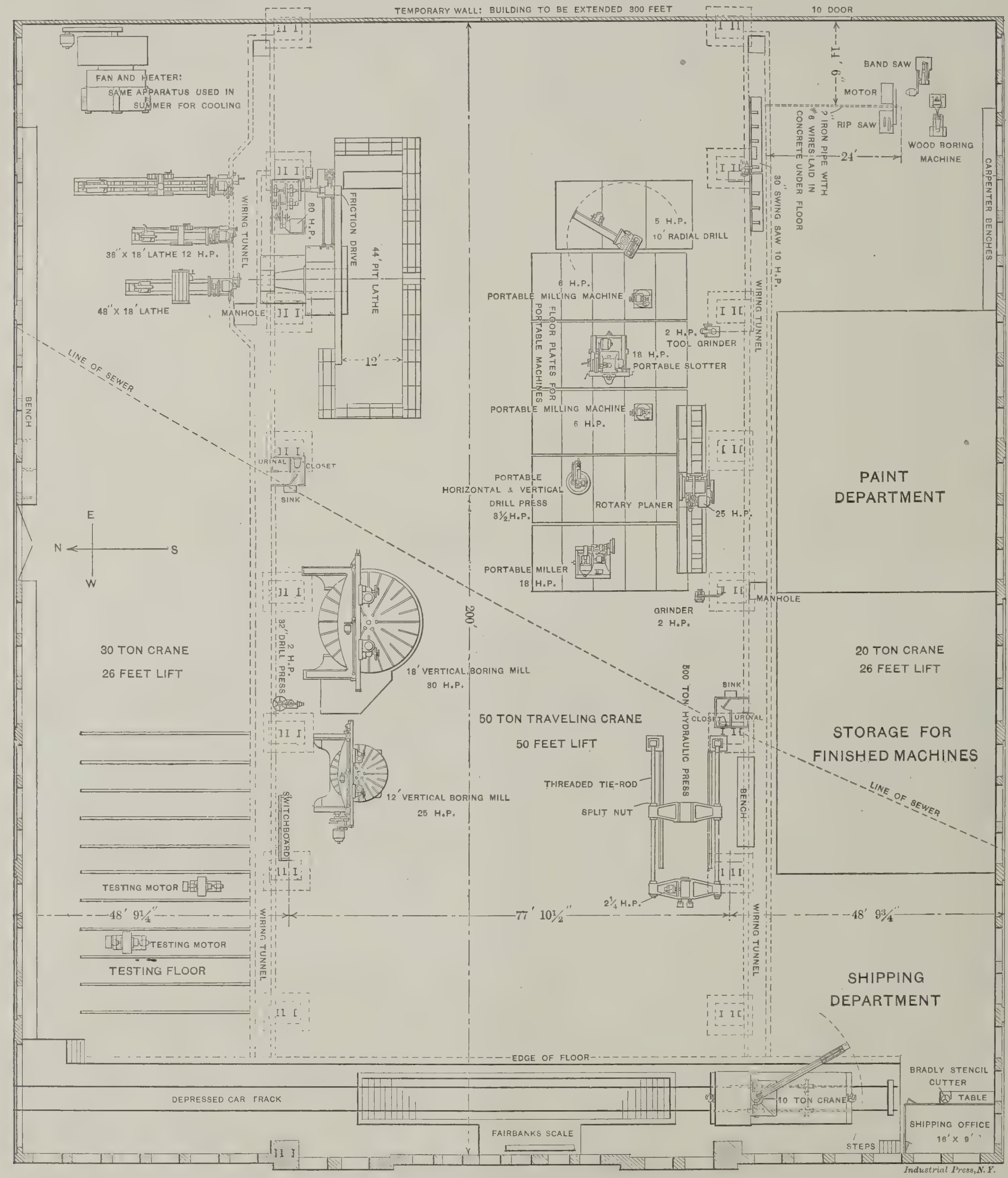


Fig. 1. View of West End Shop No. 3, Bullock Electric Mfg. Company. Service Building at Left.

The shop is heated in winter by the Buffalo Forge hot air system. The conduits are carried through the side bays at a height of about 35 feet from the floor and the air is discharged at this height, the nozzles not being carried down near the floor. The heater and circulating fan are located in the northeast corner where they will be quite centrally located when the extension is built. The same apparatus is used in summer to cool the shop, cool air being blown through the pipes the same as warm air is in winter. The air in summer is drawn from the outside and passed through pipes around which cold water circulates. This system was found to be quite successful during the past summer and very agreeable to the workmen.

The floor has several features of interest. The foundation consists of rock concrete 2 feet deep in which the sleepers are laid and grouted. On the sleepers are laid 2-inch oak plank, This applies to the main floor. The testing floor in the northwest corner where the large machines are subjected to running tests, has a foundation of rock concrete 16 inches deep in which are buried at 5-foot centers 12-inch steel I-beams. On top of the I-beams are laid 2-inch planks and on these are laid 2-inch pine planks or flooring. The cast-iron floorplate in the middle bay, upon which the portable milling machines and slotters are used, is 60 feet long and 27 feet 8½ inches wide. It consists of 25 sections like that shown in the working drawing, Fig. 6. The T-slots in each section are continuous, but at the ends a transverse groove or slot 2½ inches (1¼ inches on each section) is provided for the convenient removal of chips and other debris. The general views, Figs. 4 and 5, show the floorplate with tools at work and Fig. 7 shows the floorplate with the rotor of a 3,200 K. W. generator in the foreground. In this view the 10-foot radial drill at the left is mounted on a separate floorplate of three sections. It, of course, may be shifted to any part of its floorplate required for advantageous working, the stump being provided with a circular base with bolt holes for this purpose.

All tools and machines are electrically driven by independent motors save, of course, the pneumatic hammers and drills used on the erecting floor. The electric power wires are laid in two wiring tunnels or subways located on each side of the middle bay. The location of the principal machines and of the testing floor and floorplate is such that the wiring tunnels serve them with comparatively short leads. Inclosed arc lamps are used and the wiring for these and the traveling cranes is, of course, carried overhead.



Industrial Press, N.Y.

Fig. 2. Floor Plan of Shop 3—Bullock Electric Mfg. Company.

A railway switch enters from the north side and crosses the west end. The tracks are depressed so that the floor of a flat car is on a level with the shop floor. A Fairbanks track scale enables all car weights to be determined independently of the railway company; also all castings received from the foundry both individually and in bulk. A 10-ton derrick car is part of the plant equipment for handling heavy parts and is indicated in the shop plan, but of course the shop traveling cranes are preferably used for loading and unloading cars unless otherwise employed.

The largest machine tool in the shop is the 44-foot pit lathe indicated in the plan and shown individually in Fig. 8, working on an armature shield and support for a 3,200 K. W. alternating current generator. The machine can be used either as a lathe or as a boring machine, being used in the latter capacity in this instance, since the work remains stationary while the boring tools revolve with the faceplate. The faceplate is 30 feet diameter and the pit will permit a casting 44 feet diameter and 12 feet long to be swung. The novel feature of the lathe is the friction drive, power being transmitted to the periphery of the faceplate by a friction wheel or roller 18 inches diameter and 15 inches long. A slotted cast-iron

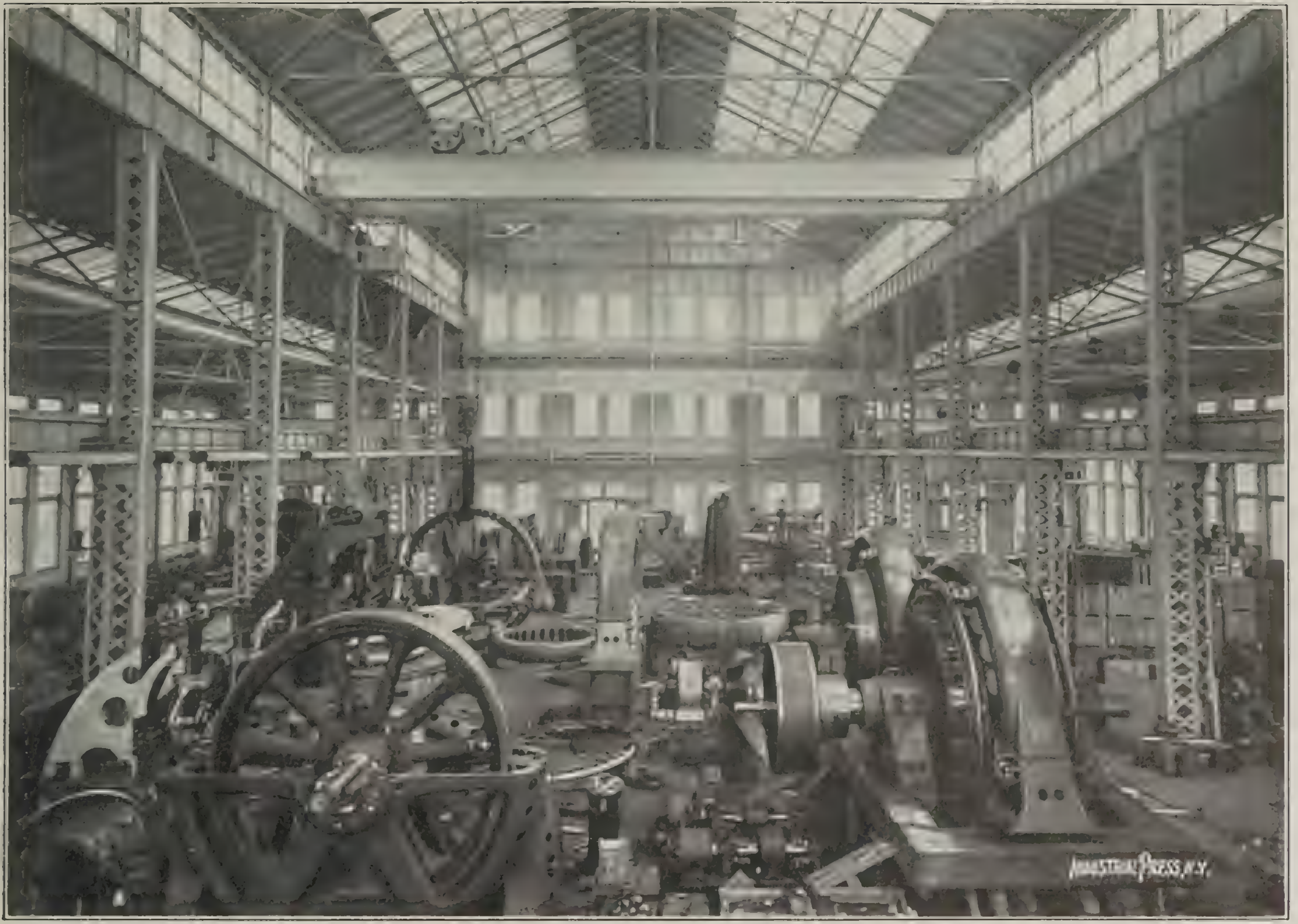


Fig. 3. General View of Shop, looking East.

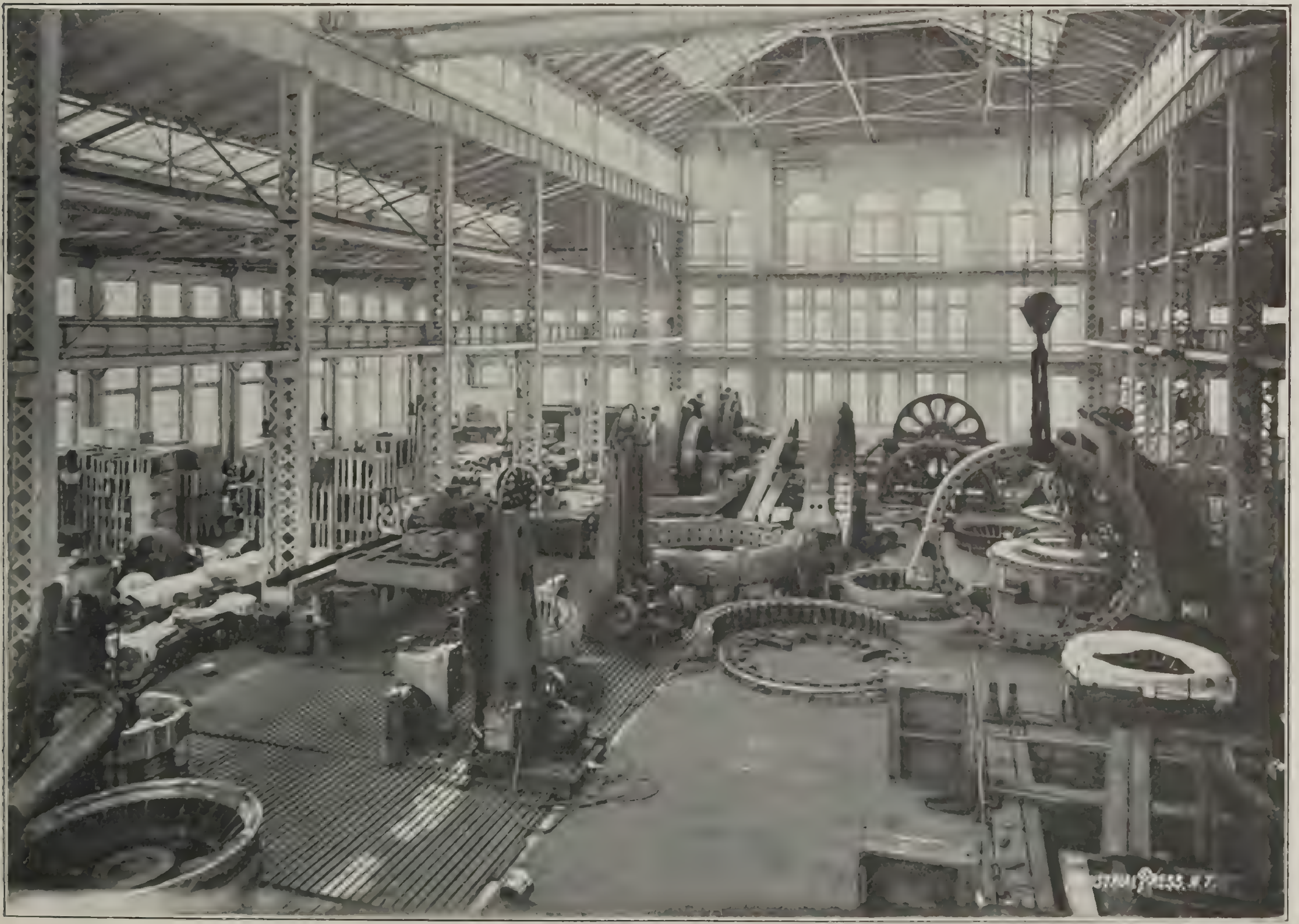


Fig. 4. General View, looking towards Southwest Corner.

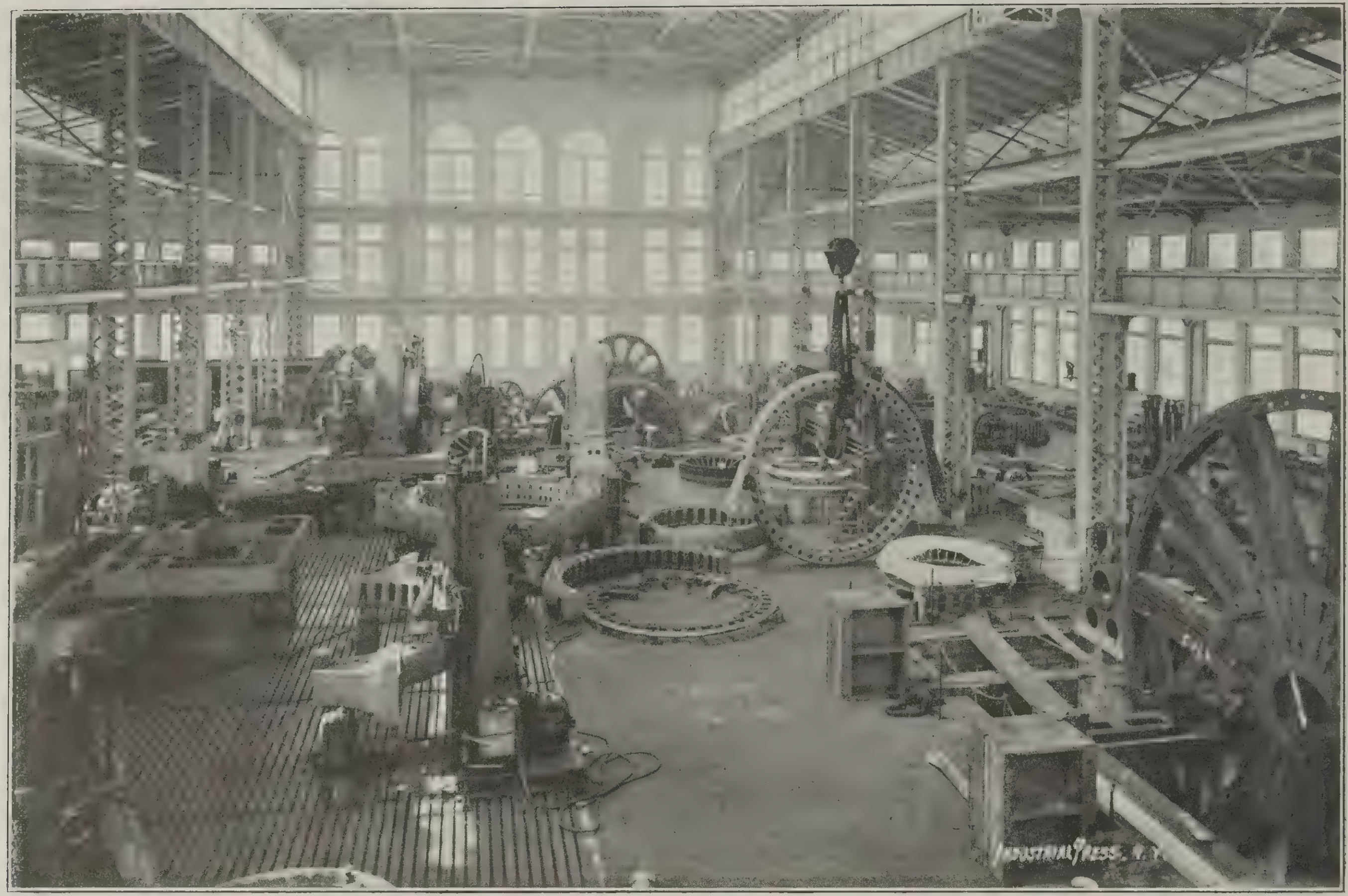


Fig. 5. General View of Shop, looking Northwest.

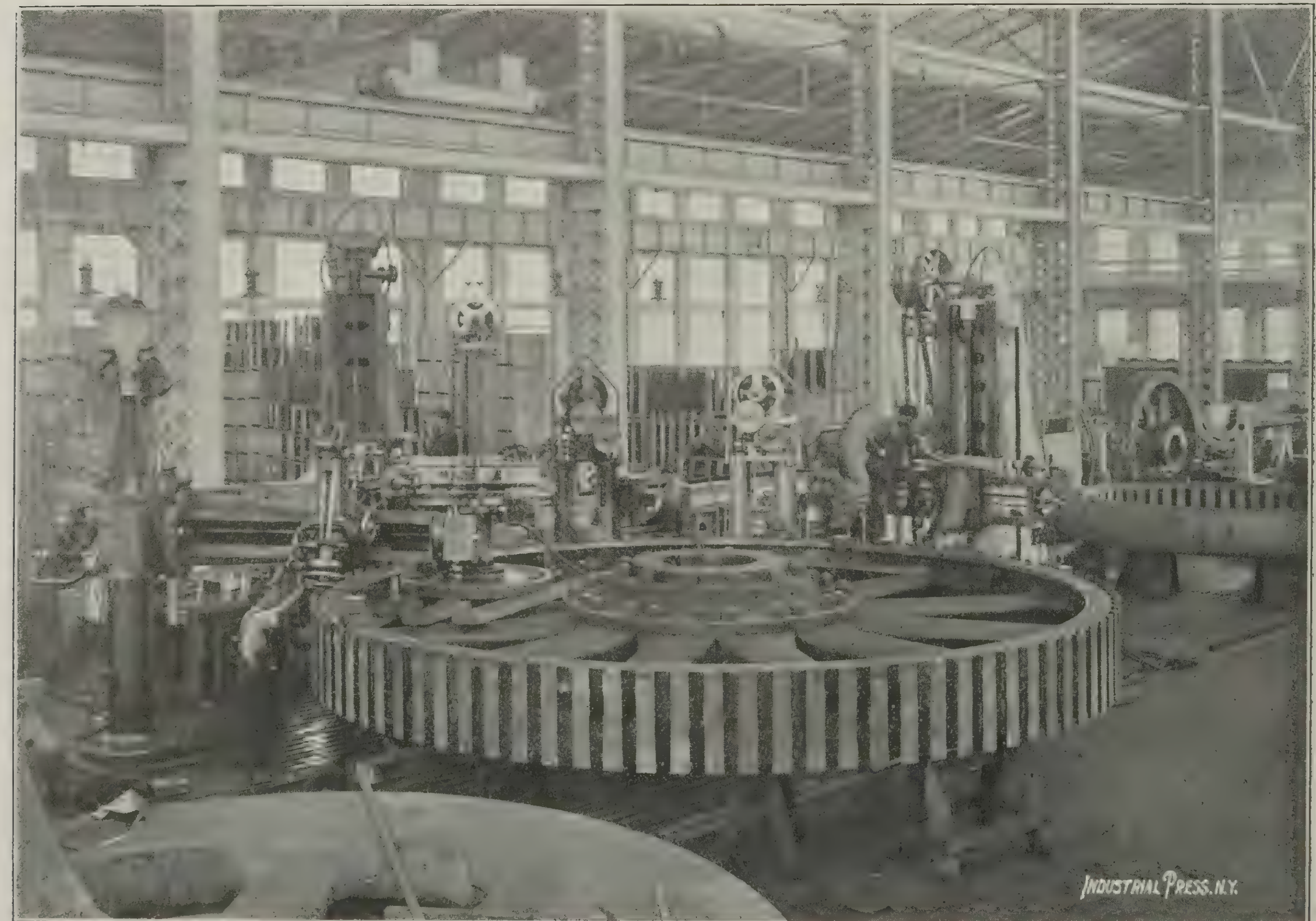


Fig. 7. Floorplate, showing Rotor of 3,200 K.W. being Machined.

floorplate is laid on three sides of the pit for the erection of work that is to be bored and for supporting the cutting tools when work is swung on the faceplate. The floorplate will be used for the latter purpose only when the full capacity of the pit is taken up. Ordinarily the turning tools are supported on massive cast-iron columns resting on the floor of the pit. The feed mechanism of the tool carriages is driven by an independent motor controlled by a feed regulator so that any rate of feed from 3-64 inch to 2¾ inches per minute may be gotten and strictly in accord with the movement of the faceplate. The floorplate is also used for an outboard bearing or support for boring bars and mandrels when turning or boring large rotors or flywheels. The total weight of the lathe is estimated at 480,000 pounds. Fuller particulars of the friction drive were contributed by Mr. John M. Barnay in the January, 1903, issue. The company are satisfied with the friction drive as applied to this particular machine, since it suited the purpose better than any other drive. It works even better than they anticipated. In general, however, they do not advise the use of the friction drive for machine tools.

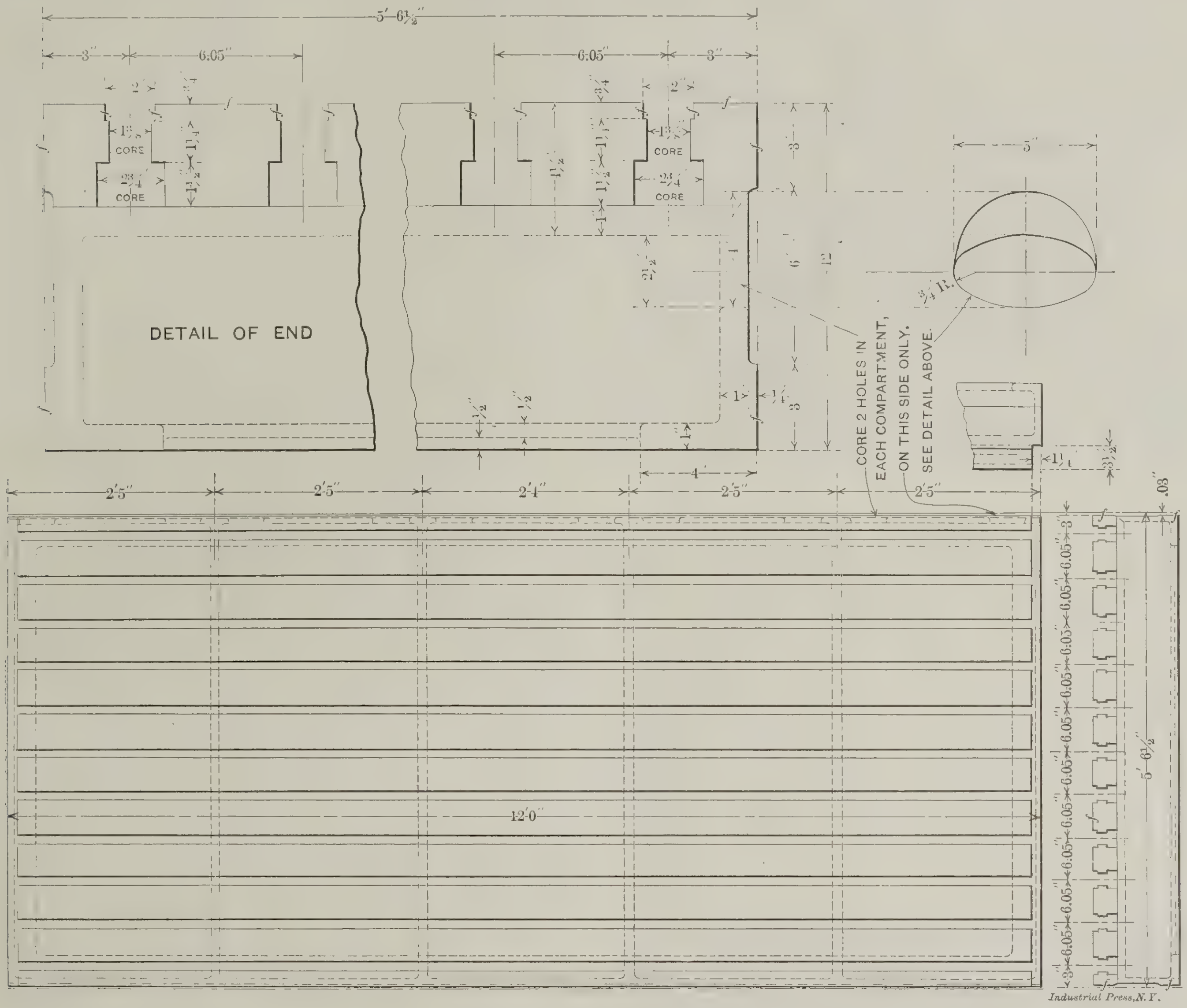


Fig. 6. Details of a Floorplate Section.

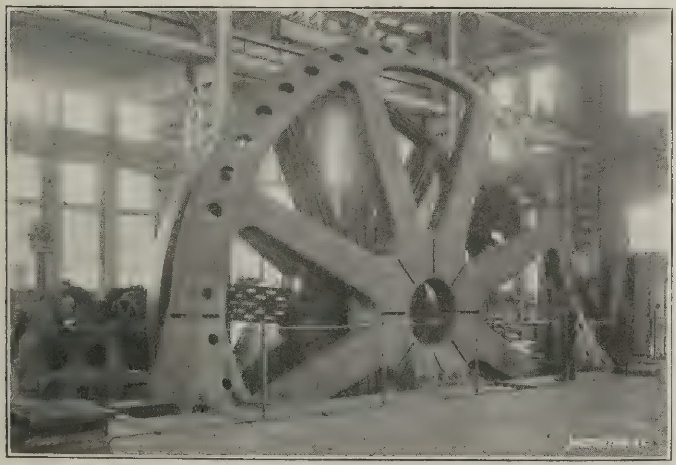


Fig. 8. Forty-four foot Pit Lathe.

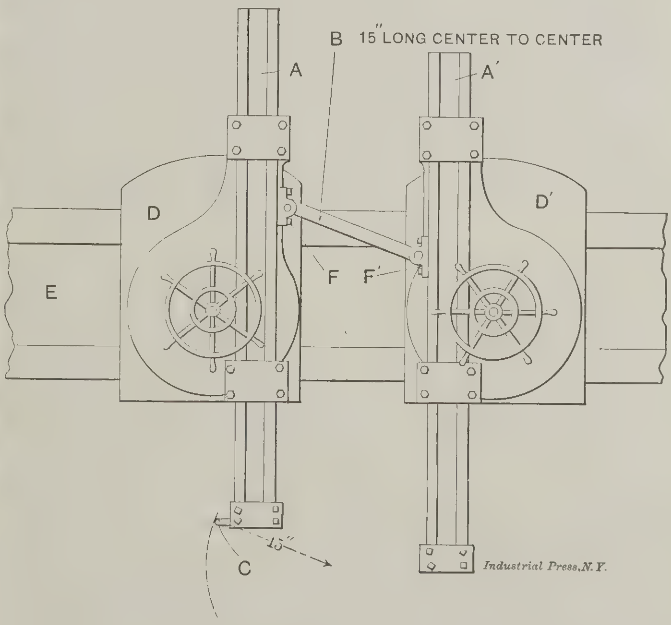


Fig. 9. Boring Mill Attachment for Boring Spherical Seats.

On the same side of the middle bay as the pit lathe are two vertical boring mills of 12 and 18 feet capacity respectively. Both these mills have been adapted to boring spherical seats for the self-aligning bearings used on all large generators. The device is shown in Fig. 9 and consists essentially of the bar or link *B*, which is made of the required radial length from the centers of the pin holes in the ends, links of different radii being provided to suit the work. The blocks *F F′* are secured to the boring bars by two screw bolts each and either bar can be used for boring a spherical seat. The bar *A* is supposed to be so employed in the sketch and in that case the slide *D* is made free to move on the cross-rail *E*, the cross-feed nut or screw being disengaged for that purpose. The slide *D′* is clamped to the cross-rail and the bar *A′* remains stationary so that the pin at *F′* forms a pivot about which the link *B* swings as the bar *A* feeds down. Therefore the whole bar, including the point of the cutting tool *C*, moves in an arc of the same radius as that of the link *B*, which, in this case, is supposed to be 15 inches. The same scheme may be employed for spherical turning or for the generation of cycloid curves if required.

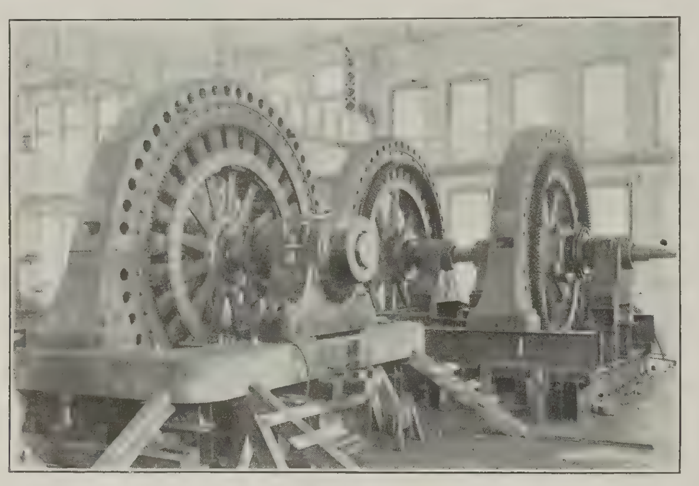


Fig. 10. Generators on Erecting Floor, in Position for Testing.

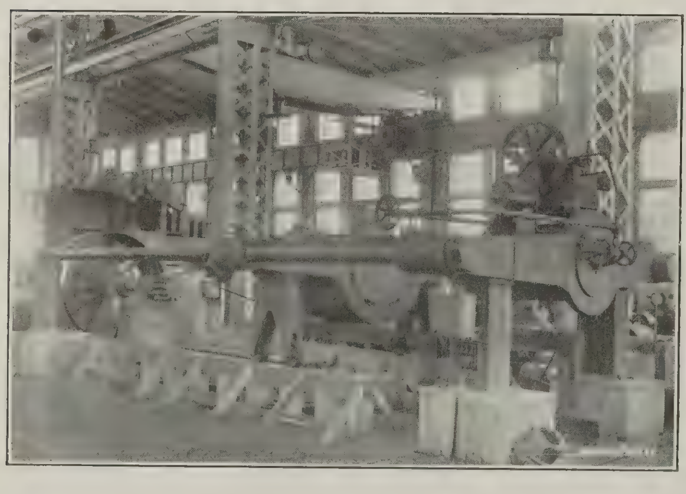


Fig. 11. Hydraulic Press, Motor-driven, for Forcing Fits.

Another feature of these boring mills which is of minor interest is that the counterbalance weights are not supported by pulleys on the frame or housing in the usual manner. When this is done it requires that pits be dug and bricked up for the reception of the weights when the cross-rail is raised to the top of the mill. In these cases the pulleys are mounted on the shop girders at a distance of about 25 feet from the floor and close to the columns. In this manner ample movement is gotten without making pits.

The construction of the testing floor has already been described. Fig. 10 shows three heavy generators in position on it for testing. The machine in the foreground is a 3,000 K. W., 50-cycle, three-phase, 2,400 volt, 231 R. P. M. water-wheel type alternator for the Kern River Co., California, and in the background are two 1,000 K. W., 25-cycle, three-phase, 375 volt, 94 R. P. M. engine type alternators for the Scioto Valley Traction Co.

The heavy Watson-Stillman Co. hydraulic press for forcing fits, shown in Fig. 11, is located on the opposite side of the shop from the testing floor and near the shipping department. It has a capacity up to 500 tons and is motor driven. The yoke is a heavy steel casting and is locked to the longitudinal tie rods by split nuts. The rods are cut with a coarse buttress thread and the halves of the split nuts are similarly threaded and operate substantially the same as the split nuts in a lathe apron. Fig. 12 shows one end of the yoke more in detail. *A* is the yoke, *B* detachable handle for operating the nuts, *C* is a rod connecting the opposite side so that the nuts on both sides work in unison, *D D′* are the halves of a nut, and *E* is a screwed tie-rod.

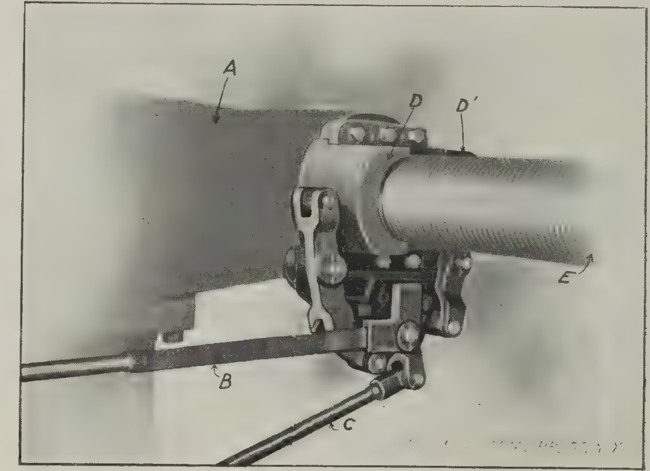


Fig. 12. Detail of Split Nut in Hydraulic Press Yoke.

Shop No. 2, which was recently badly damaged by fire, is being rebuilt and enlarged so that it will be about twice as long as the old structure. The new building will be 200 feet long and 140 feet wide and two stories high.

A dining room is provided for the employees in all the departments. The men may bring their own lunches and eat them in the dining room, or buy a well-cooked, palatable meal from the company at a nominal cost. Shower and plunge baths, lockers and the other modern conveniences are provided that so sharply differentiate the present generous policy of up-to-date concerns from that of the old regime.

* * *

The United States consul at Liege, Belgium (Mr. James C. McNally), says that the catalogue system of advertising American goods is not of much avail with the merchants of that city. The buyer wants to see the goods in bulk so that he can personally examine their details, and he wishes to listen to the arguments of the American drummer, that is, personal efforts are necessary to put American goods on that market.

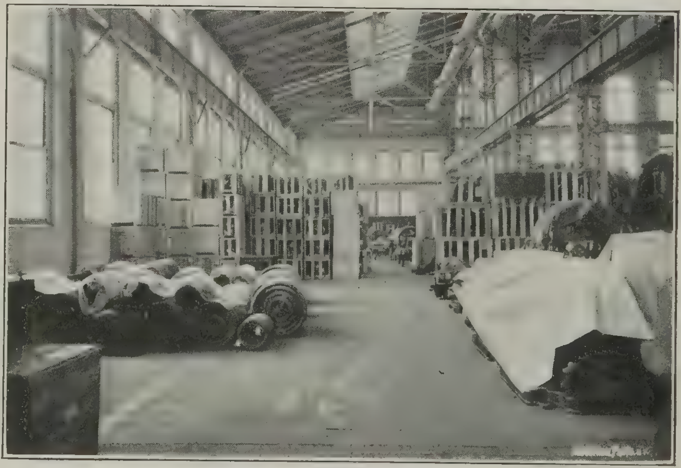


Fig. 13. Storage Department.

TOOL MAKING.—3.

REAMERS (Concluded).

E. R. MARKHAM.

Shell Reamers.—The larger sizes of chucking reamers are oftentimes made in the form of "shell reamers." As several reamers may be made to be used with the same arbor, there is a great saving in cost of stock. But in order to prevent the reamer turning on the arbor when in use a slot is cut across one end, as shown in Figs. 19 and 20, and this engages with a pin passing through the arbor, or a tongued collar on the arbor. Owing to the liability of change in size of hole in the reamer when hardened, it is necessary to leave a small amount of stock in the hole, to be ground out after hardening; or the hole may be made tapering and the arbor given a corresponding taper to fit the hole.

When making shell reamers, select stock enough larger than finish size to allow of turning off all the decarbonized portion. The piece should be placed in a chuck on the lathe and a hole drilled and reamed through it 1-16 inch smaller than finish size. It should then be placed on a mandrel and turned to a size 1-32 to 1-16 inch larger than finish, after which it should be annealed. This is to eliminate any tendency of the piece "going" to any great extent when hardened. This process should be employed when making almost any piece of work that we wish to prevent from altering in shape or size of hole when hardening; it also helps to decrease the tendency to crack from internal strains when the article is hardened.

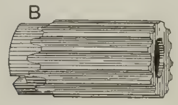


Fig. 19.

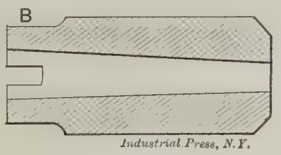


Fig. 20.

After annealing, the piece is placed in the chuck and the hole finished to grinding size, which ordinarily would be about .005 inch smaller than finish. If a taper-shaped hole is desired, it may be bored and reamed to the desired size and taper. When this form of hole is made in a reamer, it is not generally considered necessary to make any allowance for grinding, as any slight inequality of size would be taken care of by the shape of the hole in the reamer and arbor it is to be used on. When the hole is finished the blank may be placed on a mandrel, the ends faced to the desired dimensions, and the reamer part turned to a size .010 to .015 inch larger than finish size. The portion marked *B* at the end of reamer may be turned to finish size. If we are making a rose reamer, the cutting end should cut to the proper bevel.

Before cutting the flutes that form the cutting edges it is advisable to cut the tongue slot in the end. To accomplish this the reamer blank may be placed in the chuck on the index head spindle of the milling machine; and as this slot must be central, extreme care should be exercised in setting the machine and cutting it. Select a cutter somewhat narrower than the desired width of slot; set this as centrally as possible with the end of reamer, then cut across the end. Give the index pin handle 20 revolutions, thus turning the work one-half way around, and cut across again. The width of the slot that has been cut may now be measured and the saddle moved one-half the difference between the size cut and that desired. However, before taking the final cuts measure the distance from the slot to each edge of the reamer to ascertain if the piece of work is chucked true. If not, we will be obliged to cut each side of the slot to a measurement from the outside of the piece. After removing the burr thrown up in the hole by the cutting of the tongue slot, the reamer blank may be placed on a mandrel and the grooves cut. The direction given for cutting grooves of solid reamers apply to shell reamers.

If the reamer is pack-hardened the results will be more satisfactory than if any other method known to the writer is used, for the danger of cracking is eliminated and the liability of the size of the hole being affected is reduced to the minimum. However, if this method cannot be used excellent results may be obtained by heating in a muffle furnace, or in a tube in a blacksmith's forge. The reamer should be heated uniformly to a low red and plunged in a bath of water or brine—preferably the latter—from which the chill has been removed.

When the reamer is taken from the fire, and before plunging in the bath place it on a hook of the form shown in Fig. 21 in order that no part of it may be kept from the action of the water when cooling. If the reamer is larger than 1¼ inch diameter it should be removed from the bath when it ceases "singing" and be plunged into a tank of oil and allowed to remain until cool. When it is removed from the bath, whether water or oil, hold it over a fire, revolving slowly until heated sufficiently to remove the tendency to crack from the internal strains set up by hardening. Ordinarily it is not necessary to draw the temper of rose reamers. Fluted reamers may be drawn to a straw color.

The hole should be ground to size—provided it is to be ground—and the reamer placed on an arbor and ground according to instructions given for grinding reamers.

Arbors for Shell Reamers.—Fig. 22 shows an arbor for use in holding a shell reamer, having a straight hole. The smaller sizes are usually made from tool steel, while the larger ones are sometimes made from a stiff grade of machinery steel. If tool steel is used a cheap grade answers the purpose as well as a more costly article.

Make the tongues used in keeping the reamer from turning, on a separate piece from the arbor itself. Make a collar from tool steel and cut the tongues on the end as shown. These must, of course, be central with the sides of the collar. The collar may then be placed on the arbor and the pin hole drilled and reamed, after which it is removed and spring-tempered. It may now be placed on the arbor and the pin driven in place.

Roughing Reamers.—Very often when large holes are to be produced from solid stock it is found more economical to drill a hole with a drill smaller than the desired size then to enlarge it with a roughing reamer than to attempt to drill it to size. The two operations can be done more quickly than the one and then again the roughing reamer, being short and strong, will in a great measure true up the hole which may have run when drilling. This form of reamer is extensively used on screw machines and chucking machines, for enlarging cored holes.

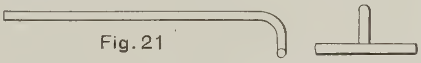


Fig. 21

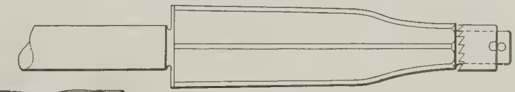


Fig. 25

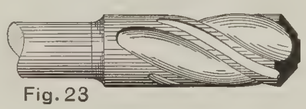


Fig. 23

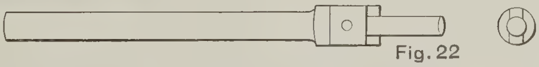


Fig. 22

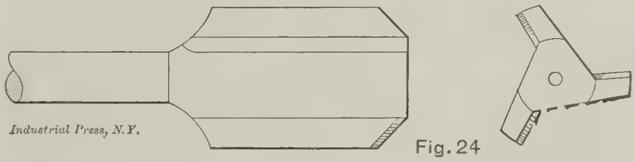


Fig. 24

The grooves are cut both straight and spiraling. Straight grooves are generally cut when the material to be machined is cast iron. When they are to be used for cutting steel, spiral grooves give best results. When the reamer is to be used for cutting steel it is best to cut oil grooves, as shown in Fig. 23, as these grooves convey lubricant to the cutting edges, and as they remove a portion of the land the frictional resistance is reduced.

When the tool is to be used for machining large holes—those above 2 inches—the form shown in Fig. 24 is preferred by many mechanics for use on either cast iron or steel, the grooves being straight as shown. The flutes are large and easily accommodate the chips and at the same time convey the oil or other lubricant to the cutting edges.

As the use of this form of reamer is generally followed by a boring tool, to true up the hole in case it may have run, it is not essential that it cut exact as to size, and consequently it need not be ground after hardening. However, if it is considered necessary to grind to size a sufficient allowance may be made when turning in the lathe, and as the centers are left in the piece, the grinding is a simple matter.

Formed Reamers.—Formed reamers are used to ream a hole of irregular contour. They are employed very extensively in shops where fire arms are manufactured, for reaming the end of the barrel that goes in the frame to receive the shell, and are then generally termed "chambering reamers." That these reamers may retain their size and shape for as long a period as possible they are made in sets. A roughing tool cuts out the principal part of the stock, then a reamer a trifle smaller than finish size is used, leaving a very small amount to be removed by the finishing reamer.

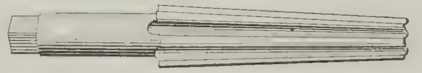
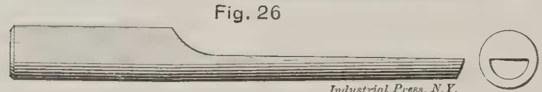


Fig. 26



Industrial Press, N.Y.

Fig. 27

As it is necessary to machine the formed hole in exact alignment with the rifled hole in the barrel the reamer must be provided with a pilot of the exact size of the hole at the tops of the lands of the rifling. Such a reamer is shown in Fig. 25. And to prevent the lands of the rifling from becoming marred by the pilot, this part is made a trifle small, and a sleeve is placed on the outside of it. This does not revolve when the tool is cutting; the pilot proper being a running fit in the hole in the sleeve revolves in it. But the tendency of the reamer is to throw a burr at the end where it stops cutting, and should we attempt to draw the sleeve back through this burr it would get stuck and in all probability spoil the rifling. To avoid this we must remove the burr and for this purpose teeth are cut on the sleeve on the end toward the reamer, as shown. A pin is driven through a hole in the pilot, just beyond the end of the sleeve, thus leaving the sleeve free when the pressure on the reamer is ahead; and grooves are cut in the end of the sleeve toward the pin, as shown. Now when we draw back on the reamer the grooves in the sleeve engage with the pin, the sleeve turns with the reamer and the teeth on the opposite end cut away the burr. As the teeth are to be on the opposite end from what general practice would call for, attention must be given as to which way they face, so that they may cut.

Reamers of this character must be exact as to shape, and it is therefore necessary to make them to gages. First, a sheet steel gage is used, to shape the general outline to; then a receiving gage, which consists of a block having a hole of the right size and shape in it, in order that the fit may be easily observed. A portion of this block must be cut away, leaving a trifle more than one-half the hole in the block.

Owing to the peculiar shape of a reamer of this style, and to the fact that it is so slender that it would not be possible to use a forming tool to shape it, it may be roughed somewhere near to shape with the ordinary lathe tools, but the finishing to shape and size must be done by means of hand tools. Where these tools are made in quantities sufficiently large to warrant the outlay a special form of turning lathes may be made, but for ordinary purposes the method described is used.

To prevent change of size, and springing, it is advisable to harden tools of this character by the pack-hardening method. If this cannot be done, however, the piece should be heated in a muffle furnace, or in a pipe in a forge, and dipped in luke-warm brine. If shape or size is altered it may be fitted to gage by oilstoning.

Taper Reamers.—Taper reamers are used for various classes of work. We have in common use roughing taper reamers, finish taper reamers, dowel pin taper reamers, etc. These are made with straight flutes, as shown in Fig. 26, and also with spiral flutes. Then we have the half reamer with only one cutting edge, as shown in Fig. 27.

Ordinarily the roughing taper reamer is simply intended as a means of removing stock so that the finish reamer will not have much work to do, that it may maintain its size and shape as long as possible, and cut a smooth hole accurate as to size. It is made of a form that breaks the chips into short lengths, that is, in the form of what is sometimes termed a "multiple counterbore," as shown in Fig. 28. Each of the bodies, *B*, *B*, is straight and a trifle larger than the one preceding it. The stock at the end of the body is cut somewhat below the size of the next smaller body, by cutting grooves, *A*, *A*, as shown, with a parting tool whose corners are slightly rounded to prevent cracking when the reamer is hardened. It is customary to give roughing reamers of this character four flutes. The ends of the steps are given clearance so that they may be cut, which is done by filing. The commercial "roughing taper reamer" is usually made as shown in Fig. 29; this has a thread cut its entire length, as shown, to break the chip.

In cutting the thread which should be left-hand, use a square-thread tool having its corners slightly rounded. The tool should be about 1-16 inch thick; the thread cut about 1-32 inch deep. After the grooves are cut the reamer may be hardened, the temper drawn to straw color and the reamer ground to size and to the proper taper. Then it may be given clearance for cutting, which is done by grinding, as explained under grinding fluted reamers, excepting that the grinding may extend to the cutting edge of the tooth. The proper clearance for cutting extends back about 1-32 to 1-16 inch from the cutting edge—according to size—the remainder of the tooth being given greater clearance.

Taper reamers intended for reaming holes to receive taper dowel pins are made of the same form as a finish taper reamer, or as a "half" reamer like that shown in Fig. 27. The latter form is in general use in many shops, while the commercial article is usually made of the first form.

When exactness of shape is desired the reamer must be made of the form shown in Fig. 30, leaving the portion at small end full size until the reamer is ground, in order to preserve the center. After being ground to size and shape the extra portion may be ground away, leaving it of the shape shown in Fig. 27. When milling articles of this sort it is necessary to support them from the milling machine table with the adjustable support furnished with the machine, or by some means to prevent springing from the pressure of the cutter.

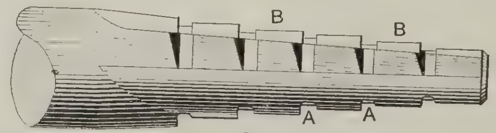


Fig. 28

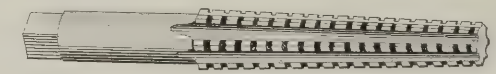


Fig. 29

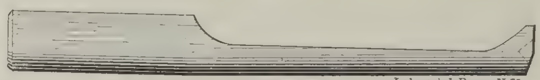


Fig. 30

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When hardening, heat very carefully in a tube in the fire, then dip in the bath with the reamer inclined, as shown in Fig. 31, the heavy portion being down to cause it to cool quickest. This keeps it straighter than if it were dipped in a vertical position; the angle of inclination cannot be given, it must be determined by experiment.

If the reamer is ground in a dry grinder care must be exercised that a coarse, free cutting wheel be used; for the reamer will spring if heated, as all of the heat would be applied to one side. After grinding the round portion may be honed, being careful to come only to the cutting edge. The honing is to relieve the bearing surface, or rather to reduce it.

Finish Taper Reamers.—Taper reamers used for finishing holes are usually made to appear like Fig. 26, although the grooves are sometimes cut with a right-hand spiral, which tends to make them cut a smoother hole, especially if the stock is porous, or the walls of the hole imperfect. A spiral of this kind would not do on a straight fluted reamer; the tendency would be to draw into the hole being reamed faster than the reamer could cut, and consequently when the flutes of straight reamers are cut spiraling they are given a left-hand spiral. But on account of the inclination of the sides of a taper reamer the amount of spiral usually given would not cause it to draw in, although it might cause it to cut somewhat easier than if the flutes were straight.

Square Reamers.—This form of reamer is used mostly by makers of gun barrels and similar work. It differs from the other forms of reamers in that the cutting is done on the end nearest the shank. The reamer is pulled through the hole rather than pushed through, as is generally the case. This form of reamer is sometimes termed a "chip reamer" on account of the method used in enlarging the size of the hole cut with it. A chip of wood is placed on one side, as shown in Fig. 39. When the size of the hole should be increased a small amount a piece of paper—or tissue paper—is placed between the chip and reamer.

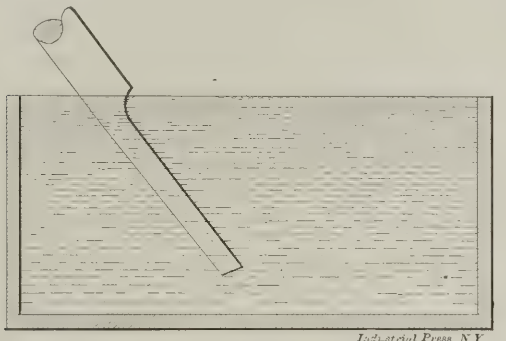

Fig. 31. Proper Position of "Half" Reamer in Hardening Bath.

This form of reamer is turned a size somewhat larger than the size across corners, then milled square. When large reamers are made a convex cutter is used to mill the sides concave; but small reamers are milled square on their sides and the concave surface is obtained by the emery wheel when grinding. The shank is made short and after the reamer is ground to size it is brazed or welded to a long shank.

After the reamer is hardened it is placed in the grinder, the corners ground to size, and the sides also ground. The concave shape is given by the face of the emery wheel—and should not be carried quite to the corners. The end toward the shank is made slightly tapering for a short distance for the cutting portion. Now by using a flat oilstone we can hone the reamer slightly flat at the corners, and this prevents its digging into the work. This form of reamer is used to remove a very small portion of stock at each cut and will cut a very smooth hole.

Single Lip Reamer.—This form of reamer is used very extensively in some shops, while in other shops it is never seen. For certain purposes it is more satisfactory than any other form of reamer. As it has but one cutting edge its action is similar to that of a boring tool used for lathe work. And as more than one-half the stock is left on the reamer when it is milled for the cutting edge it is supported in the hole, and if properly started, will not run when cutting, but is bound to produce a straight hole.

The form of single lip reamer shown in Fig. 32 is the one commonly used. Select stock somewhat larger than finish size. When turning in the lathe leave portions *A* and *B* somewhat larger than finish, to allow of grinding. *C* is turned to dimensions given, because it is not essential that it run true. The size, and any distinguishing marks desired, may be stamped here.

When milling for the cutting edge do not mill away quite one-half the stock, as more than one-half the circumference of the reamer is required to support it in the hole when cutting. If the countersunk hole (center) in the cutting end is made small we need not mill away sufficient stock to disturb it. If, however, the center should be large and the reamer a small one, we can mill it as shown in Fig. 33, leaving it this shape until after it is ground to size. Then the end containing the deep center may be removed by grinding, leaving the reamer as shown in Fig. 32. It is necessary to bevel the end of the cutting portion as shown, while one-half of the end is beveled off so as to be out of the way, or it would strike on the opposite side of the hole from the cutting edge and prevent the reamer penetrating the stock. When hardening reamers of this character it is important that they be hard the entire length of body (*A*, Fig. 32) or they will be apt to rough up in the hole being reamed. Unless they are small the temper need not be drawn.

Single lip reamers are made at times with a pilot, as shown in Fig. 34. This pilot, which is considerably smaller than the hole it is to pass through and which is to be reamed, fits a bushing at the further end of the hole. The bushing receiving the pilot guides the reamer and causes it to cut the hole at the desired location. This form is made the same as the reamer without pilot; enough stock is left on pilot to finish to size by grinding after hardening. It is necessary to neck down at the end of the pilot nearest the cutting portion so that the reamer may be given clearance by filing, and also to allow the emery wheel to pass over the pilot when grinding.

Reamers with Inserted Blades.—Generally speaking it is not good practice to make small reamers with inserted blades. Large reamers are, however, made this way (see Fig. 35) as a matter of economy. Not that the first cost is any less; but it is possible, when the blades are worn so that the reamer cuts small, to insert new blades at a cost much less than that of making a new solid reamer. Then again the reamer may be so made that the blades may be made to cut larger by moving them. It is then called an expanding reamer.

The body of an inserted-blade reamer may be made of a cheap grade of tool steel, or of a high-carbon machine steel. It would not be good practice to make the body of ordinary low-carbon machine steel, as it would not resist the pressure of the blades on the sides of the slots when the reamer was in use; and if they became loose in the slots the reamer would be of no use, as the blades would bite into the walls of the hole and prevent the reamer cutting and in all probability spoil the piece being reamed.

After turning to the desired size the slots may be milled in the body. These slots should be milled somewhat shallower at the end toward the shank than at the cutting end, and they should also be wider at the bottom than at the top in order to hold the blades from being drawn from their seating. The side of the slot corresponding to the cutting edge of blade should be radial—on a line with the center—or slightly ahead of the center, according to the custom in the individual shop. For milling the slot wider at the bottom we may use a cutter slightly narrower than the desired width of the slot at the top. Set this cutter to bring the face of blade in proper location and the desired depth, mill all the slots, then turn the index spindle the necessary amount to give the proper angle on side of slot corresponding to the back of tooth, as shown in Fig. 36. As stated, the slots should be less deep at the end toward shank than at the front end. This may be easily accomplished by lowering the index head spindle sufficiently to produce the desired result.

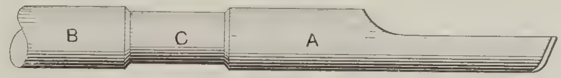

Fig. 32

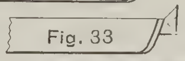

Fig. 33

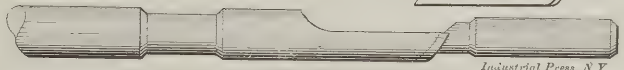

Fig. 34

The blades are machined to shape and hardened; they are then driven to place and ground to size. The clearance is given the same as a solid reamer of the same class. A reamer need not be made of as high carbon steel as tools whose cutting edges are heavier, as the water has free access to the surfaces and the portions not being very heavy, harden very readily. On the other hand, while it is advisable to use a steel of a percentage of carbon especially adapted to the class of tool being made, in shops where detail is closely followed and where the hardener is sufficiently versed in the proper method of treatment for each grade of steel, yet in the average shop this would lead to endless confusion. For this reason it is best as a rule to select some certain make and grade of steel and use it for as great a proportion of the tools as is possible. Probably the most satisfactory percentage of carbon, when almost any of the leading makes of steel is used, is that containing 1¼ per cent. of carbon.

Adjustable Reamers.—When it is desired to ream holes to varying sizes, regardless of interchangeability, reamers are used which can be adjusted to the desired size. In most shops they are a source of endless annoyance, because they are never adjusted to the proper size when found, and in nine cases out of ten a man will ream a hole too large before he succeeds in setting it right. However, they have their uses and in many shops are indispensable.

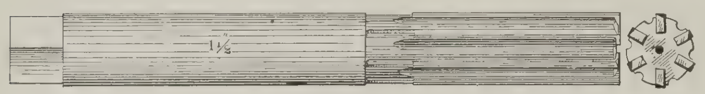

Fig. 35

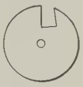

Fig. 36

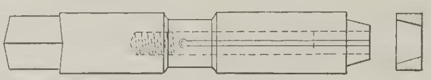

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Fig. 37

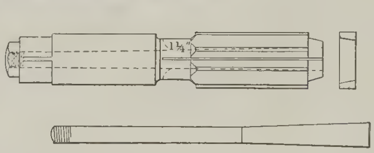

Fig. 38

There are many forms of the commercial reamer, but as most of these require special machinery and tools for their manufacture we will simply consider the most common form—shown in Figs. 37 and 38—which differ from each other simply in the form of the expander.

For making this form of reamer select stock from 1-16 to ⅛ inch larger than finish size. After the ends have been squared to length, the piece of steel should be turned straight and true to a size at least 1-32 inch larger than finish. When drilling the end as in Fig. 37, to receive the expanding screw, the outer end should be run in the back rest while the opposite end should be so strapped against the live center of the lathe that there will be no strain sideways to draw one side of the countersunk hole away from the center. In other words, it should be drawn back squarely against the live center, which should run true. The outer end may now be drilled and reamed to the proper taper. Care should be exercised when doing work of this character that the drill is started true and that it does not run. When it is exceedingly important that the drilled hole be concentric with the outside of the piece, drill a hole ¼ inch or so deep, with a drill 1-32 inch smaller than the size we desire, then with an inside turning tool bore the hole to a size to permit the drill we intend using to enter this hole. It should be a nice fit in the bored hole. There will be very little danger of the drill running, unless it is too thick at the point, in which case it should be "wheeled out" to bring the point to the proper thickness, so that it can cut properly. A drill which is too thick at the point never does good work unless a small drill is run in ahead of it. After drilling, tapping and reaming with a taper reamer the end of the hole should be chamfered to the same angle as the lathe center (60 degrees) to provide a bearing on the center when turning and grinding to size. If this chamfering is done with a tool held fast in the toolpost it will be true with the outside surface which is running in the back rest.

After removing from the back rest the reamer may be turned to a size .010 to .015 inch larger than finish, the wrench end milled square, the teeth cut and the reamer split to allow it to expand. When splitting, use a metal-slitting saw the thickness of which will depend on the size of the reamer. A small reamer requires a thin saw; a large reamer, a thicker one. The splitting should not extend quite far enough toward the end to part the stock and a thin partition should be left until after hardening, to prevent the reamer springing out of shape. This partition may be removed after the reamer is ground, by means of a small, thin emery wheel, or a beveled wheel. A serious mistake when making articles that are split after the fashion of the reamer under consideration, is to carry the saw cut to the end and entirely sever at this point. This leaves the different portions free to go where they please when hardened, thereby occasioning much annoyance, and sometimes rendering the article unfit for use. When hardening, the reamer should be dipped in the bath with the cutting end uppermost, to do away with any tendency for the piece to crack where the narrow partition is holding it.

If the reamer is made as shown in Fig. 38 the above instructions hold good except that it must be reversed in the lathe and the hole for the expanding rod drilled in to meet that from the opposite end. In this case we do not tap the hole. The nut draws the expanding rod into the tapered hole.

The collar which goes on the end supports the cutting edges by drawing them onto the expanding rod, and preventing their opening when in use.

This form of reamer is open to the objection that the cutting end is slightly larger than the balance of the tool; but when the reamer is only expanded a limited amount this objection is not serious in the case of such work as this class of reamer is used on. When it is necessary to have a reamer that will expand uniformly its entire length, it is made with inserted blades which are adjusted by means of a nut at each end, the blade being held in slots which are cut deepest at the cutting end of the reamer.

* * *

EXPORTS OF MACHINERY.

Machinery forms by far the most important feature in our exports of iron and steel manufactures. Statistics upon these products are divided into groups, such as locomotive engines, stationary engines, fire engines, electrical machinery, sewing machines, typewriters, shoe machinery, cash registers, laundry machinery, printing presses, and pumping machinery, are shown in that manner. Aside from these, however, is a great group of machinery which is not stated in separate items, owing to its variety and the large number of different classes of machinery included. This single group of "machinery not separately classified" grew from 10 million dollars in 1892 to over 20 millions in 1902. The next largest item under general classification of machinery is electrical machinery, which was only separately classified in 1898, amounting in that year to 2 million dollars, and in 1902 to nearly 5½ millions. Sewing machines, which amounted to 2¼ millions in 1889, were over 4 millions in 1902. Typewriters, which were only separately stated in 1897, amounted in that year to less than 1½ million dollars, and in 1902 to nearly 3½ millions. Locomotive engines increased from 1¾ millions in 1892 to over 5½ millions in 1900, but owing to the very great demand of the home market upon the manufacturers of the United States, fell to 3¼ millions in 1902. Metal-working machinery, which was not separately stated prior to 1898, grew from 4½ millions in that year to over 7 million dollars in 1900; pumps and pumping machinery is next in order in the class (machinery), a little over 2 million dollars; cash registers grew from $813,000 in 1900, the first year in which they were separately stated, to $1,144,062 in 1902, the other classes of machinery ranging downward in their relative order of magnitude, shoe machinery, printing presses, stationary engines, laundry machinery, and fire engines. Thus machinery alone formed in 1900 55 million dollars' worth of the exports of iron and steel manufactures out of a grand total of $121,913,548 of iron and steel manufactures exported in that year, or nearly one-half of the total. This statement of "machinery" does not include agricultural implements, bicycles, telegraph and telephone instruments, or other articles not exclusively or chiefly of iron and steel. Adding only those items of machinery included under iron and steel manufactures, it may be said that the exportations from the United States of machinery as a group amounts to about $75,000,000 annually. Next in order after machinery is the group: locks, hinges, and other builders' hardware, amounting to 6 million dollars; wire, over 5 millions; pipes and fittings, 5 millions; steel rails, nearly 5 millions; tools, 3½ millions; structural iron and steel, 3 millions; boilers and parts of engines, nearly 2 millions; castings, 1½ millions; and other articles ranging downward in their relative value.

MACHINE SHOP EQUIPMENT.—6.

EQUIPMENT OF THE FORGE SHOP.

OSCAR E. PERRIGO.

It is undoubtedly true that since the very general introduction of turret lathes, forming lathes, and the large variety of similar machines now in use in almost every machine shop making any pretense to modern equipment and up-to-date methods of doing work, the forge shop has lost considerable of its importance as one of the indispensable departments upon which the machinist of former times very largely depended for much of his material for the better classes of work. The introduction of steel castings, malleable iron castings and other similar materials, superseding in many cases the old-time forgings, has also been an important factor in the same direction, and has decreased the cost of materials of complicated form, and at the same time provided the machinist with materials which have admirably answered the purpose as to strength, and lessened the amount of machining necessary for their practical use.

And yet, while the forge shop may have decreased in the matter of importance in the making of forgings, there will always remain the demand of the machine shop for a certain amount of strictly machine forgings of iron and steel which cannot be met by any other material. Many great and important advances have been made in forging by use of improved hammers, by dies in connection with them, and by the process of drop forging, yet there is a large demand for forgings requiring the services of the skilled machine forger with his expertness in hand forging, as well as his technical knowledge of handling steel of various qualities, his expert knowledge of how to produce forgings of complicated and intricate forms, and the thousand and one conditions and requirements demanded in successfully bringing out such work, correct in form and structure, and within a reasonable cost.

In the matter of casehardening and tempering the forge shop department has increased materially, as there has never been a time in the past when hardened and ground steel work has been as much used in the better qualities of machine construction as at present; and casehardening has reached such an extent that it is rare to find nuts, cap screws and the like on any well-constructed machine that are not protected from injury by this valuable process. While the actual forging work of the forge shop has decreased its scope, it has in a general way much increased in volume, since it is now customary to add to its equipment several machine tools, such as cutting-off machines, forge lathes, heavy turret lathes, cold saws, power hack saws, and other similar machines for roughing out work, which in many instances can be much more economically done by these methods than by confining the operations to forging under the hammer. In this case the appropriate machines for these purposes are included in the equipment of the forge shop and located as will be presently described, and as shown on the plan in Fig. 1.

The foundry floor, the engine foundation, and many of the foundations for machines in the machine shop, should be kept as free from jar and from shocks sufficiently strong to disturb the ground by vibrations, as possible. For this reason the forge shop is placed as far from these buildings as may be convenient; therefore, in the rear corner of the plant, and opposite the rear end of the machine shop. The spur track from the railroad, which supplies shipping facilities and brings to the plant the raw materials necessary for its use, runs across the rear end of the group of buildings, in the rear of the machine shop and storehouse. It continues in a curve around the rear corner and up the side to the foundry gate, rising as it goes, to a height sufficient for conveniently dumping coal, coke, molding sand, etc., into the storage sheds located along that side, the first of which is shown at the left of the forge shop in Fig. 1. The curve of the railroad track cuts off somewhat of this rear corner of the building space and therefore the forge shop is located far enough from the rear line to accommodate it, and the space so left is utilized for a one-story building containing a space for the forge coal, another for bar stock storage, and the wash room and water closets.

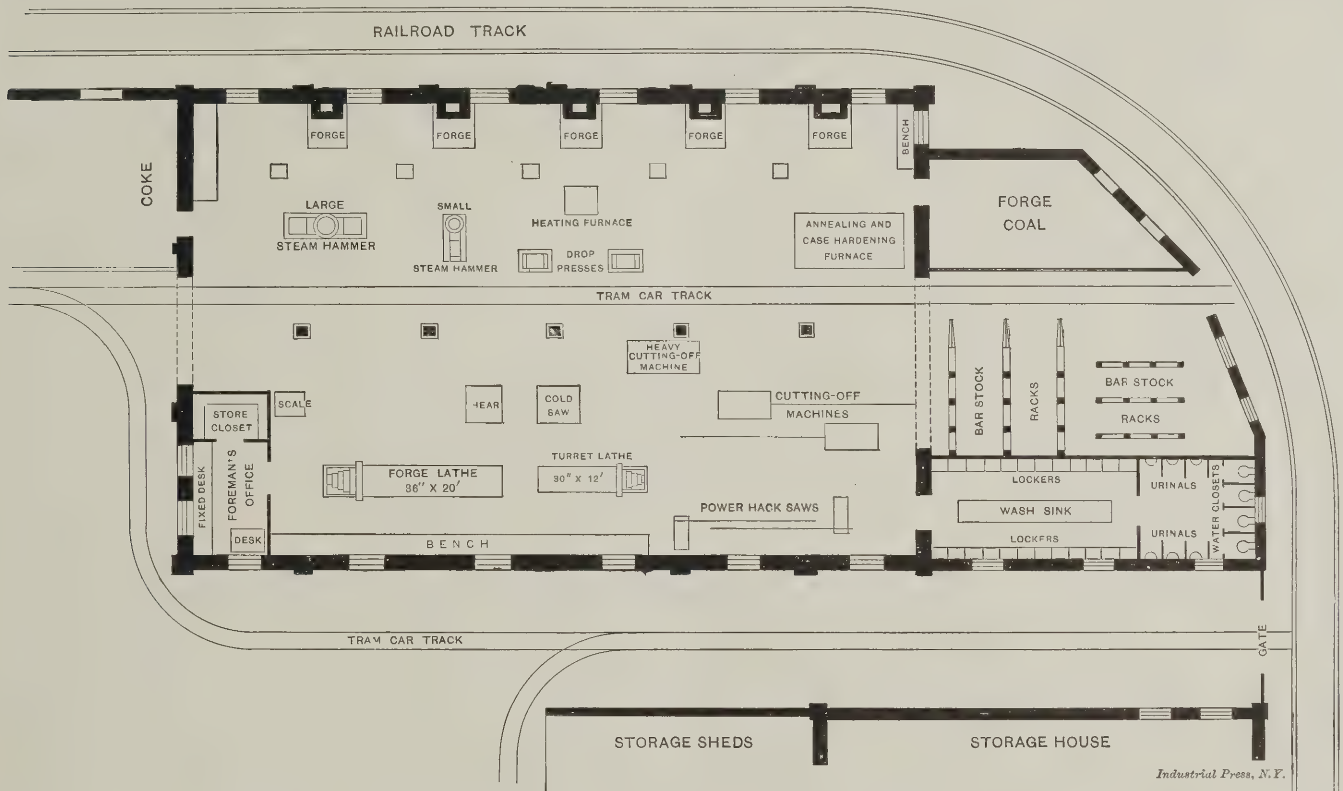

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Fig. 1. Plan View of Forge Shop, showing Proper Arrangement of the Machine Tools, etc.

The forge shop is, like the other buildings of the plant, built of brick, with steel roof construction, the roof trusses being supported in the center by steel columns. It is lighted, not only from the side windows, but from those in the monitor roof, the sashes of which are hung on pivots and controlled by cords reaching nearly to the floor, by which they may be operated when necessary for ventilation. The general plan of the forge shop is clearly shown in Fig. 1, which also shows the contiguous buildings and their positions in reference to the forge shop, as well as the location of the railroad track and the tram car tracks connecting this department with the railroad tracks in the rear and the other departments toward the front of the plant. For convenience in bringing in stock and taking out finished work the tram car tracks run nearly

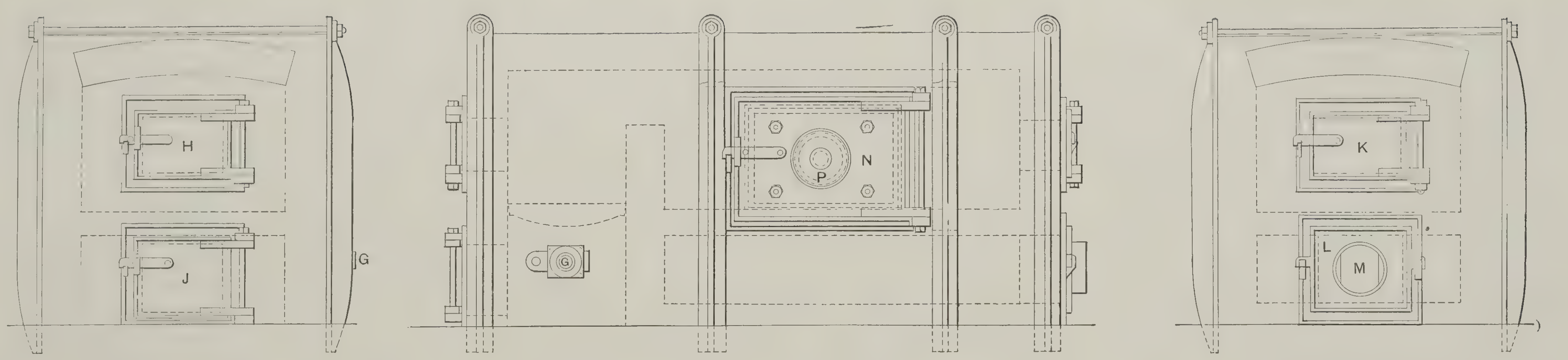

FIG.2. FRONT ELEVATION

FIG.3 SIDE ELEVATION

FIG.4 REAR ELEVATION

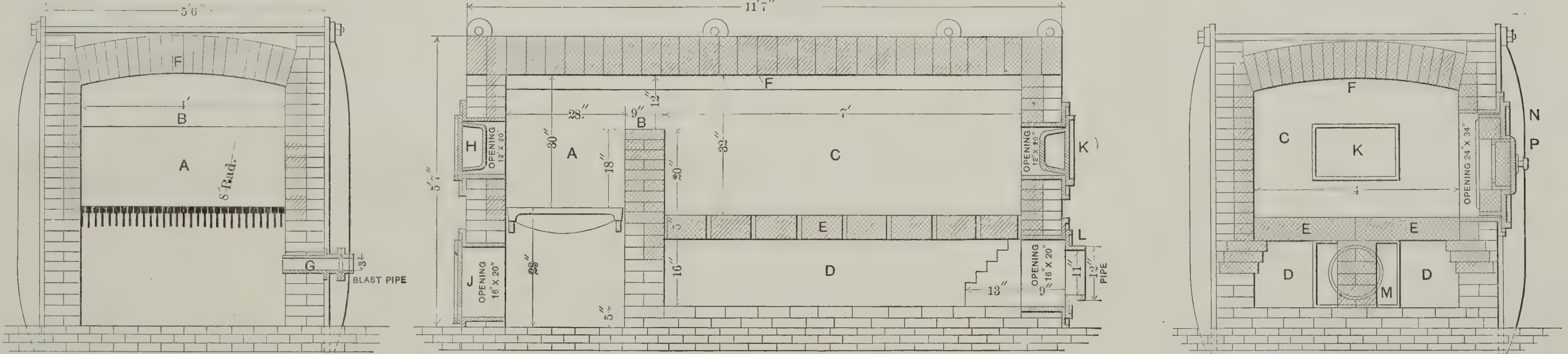

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FIG.5 SECTION THROUGH FIRE BOX, ETC.

FIG.6 LONGITUDINAL SECTION

FIG.7 SECTION THROUGH HEATING CHAMBER

Figs. 2 to 7. Elevation and Cross-sectional Views of Annealing and Casehardening Furnace.

midway through the forge shop, as shown, and are connected by their branches with the foundry, the machine shop, storage sheds, and practically all departments of the plant, as well as at three points with the railroad track, two of these being shown on the plan.

The foreman's office is located in the front corner of the shop, and has connected with it the usual foreman's store closet for such minor supplies as are more conveniently kept there than in the general store room near the offices. A fixed desk furnishes a convenient place for spreading out drawings, and a private desk is provided for the foreman's personal use. Outside of the office is a forge shop scale for weighing stock and forgings. This scale should be mounted on wheels so that it can be readily moved to any part of the shop where it may be needed.

Along the outer wall of the shop are located five regular forge fires having chimney flues built into the wall for their accommodation. These latter will not be necessary if the system of down-draft forges is used. This form of forge has several good qualities, not the least of which is that it offers less obstruction in handling large pieces of work, as it may be conveniently placed at a distance from the wall if desired, and will furnish quite as good ventilating facilities in clearing the shop of coal gas as those connected with separate chimneys. The draft may be increased or decreased at the will of the operator, particularly in the case of forges manufactured by the Buffalo Forge Company, in which a hinged and adjustable hood may be closed down over a fresh fire and raised for the handling of the work to be heated, as may be desired. If these down-draft forges are used it will be necessary to provide an exhaust fan with the proper connecting pipes for carrying off the smoke and gases, which may be delivered to one chimney, thus avoiding the expense of building the other four. Such an arrangement is very clean and wholesome for the workmen, when compared with the method shown, but considerably more expensive in its first cost, as well as requiring extra power to operate it.

The forges shown on the plan should be of such construction that the tuyeres may be readily attached and detached when necessary, for cleaning or for repairs. They should have such a form of bottom valve or gate as to readily discharge the clinkers or slag that may find its way down to it. These forges are usually constructed of cast iron and supported upon four legs, so as to give convenient access beneath them for cleaning, attaching the blast pipe, repairing, etc. Each should have, cast with it, or attached to it, two narrow troughs, running the length of its front, or shortest side, for holding coal and water. Many excellent ones are in the market and can be purchased more economically than they can be built on the premises. The blast pipe should be arranged to slide on and off easily, in case it is necessary to disconnect it for cleaning or repairs, and it should be provided with a regulating valve or gate, fitting as nearly air-tight as may be, and operated by a lever conveniently located within the reach of the operator. These forges are usually made of rectangular form, but large fires are often made upon a circular forge, whose sides extend to the floor. They need not necessarily be provided with the water and coal troughs as mentioned above, as they are usually used for heating work for the steam hammers, drop presses and similar large work, rather than for tempering, tool forging or small work of this class.

The blast for these forges, for the heating furnace for the drop presses, and for the casehardening and annealing furnace, is furnished by a fan blower designed for a pressure necessary for forge work, and having an outlet of six inches in diameter, equivalent to a No. 3 Sturtevant steel pressure blower, which is admirably adapted for this purpose. It should be located over the bench near the forges, at the front end of the shop, so that there may be no unnecessary turns or bends in the pipe leading to the forges. These pipes should be placed along the walls near the floor, but never beneath it. In one shop the writer saw blast pipes, composed of vitrified drain tiles, the joints made with Portland cement, and laid less than a foot beneath the surface of a dirt floor of the forge shop, and at one point passing directly under a bolt header. As might have been expected, the jar of the shop floor broke up the pipes and destroyed their usefulness. The blast pipes should be constructed of heavy galvanized iron, well fitted and fastened, and as nearly air-tight as may be. They should be easy of access, for the possible connection of additional pipes and for convenience of making repairs, which will have to be made sooner or later. They might be placed six or seven feet high, and along the walls, but this position will necessitate about thirty feet of additional pipe, increasing the friction of the air and consequently the power required, with no especially compensating gains other than getting the pipes up, out of the way somewhat.

Some of the more important rules for setting up and connecting forge blowers may be here given. Place the blower as near as possible to the forges. Make the pipe connections as direct as possible. If bends or elbows are absolutely necessary, make the curves of large radius, and with no abrupt angles; the inside radius of an elbow should not be less than twice the diameter of the pipe. Have the aggregate areas of all the outlet pipes at least equal to the delivery pipe at the blower. If the pipes must carry the air over one hundred feet, speed up the blower proportionately above the figures given in the manufacturers' catalogue. In any event, the blower should be run at such a speed as will give four to five ounces pressure at the tuyeres, not less than four ounces at the forge furthest from the blower.

The blower is driven from a line shaft running the length of the shop near its center. In front of the first fire is located a large steam hammer of the arched pattern, and capable of handling work up to ten inches in diameter. At the next fire is a smaller, single-column steam hammer of about half the capacity. The necessity of providing the larger hammer will be a matter to be decided by the size of the largest forgings to be made. For instance, if only a few forgings which come up to its capacity are to be made, it will be more economical to purchase them of some large forge shop than to provide a large hammer that may be idle much of the time. The smaller hammer should be provided for even moderate-sized work, for any plant of modern pretensions.

Next to the small hammer two drop presses are located, with a special heating furnace for use in connection with them. These drops should carry hammers weighing from one hundred and fifty to six hundred pounds, according to the work which they are to do.

The heating furnace need not be over thirty inches square outside, built with a cast-iron shell lined with fire bricks, supported on four cast-iron legs, and provided with a vertical sliding, balanced door in front. The heating chamber will be about twenty inches square and from ten to twelve inches high. A blast pipe leads up to it, and a smoke pipe from its rear side leads to the nearest chimney. Such a furnace will heat work for drop forging much more economically and satisfactorily than the usual open forge fire. They may be purchased at a very moderate cost.

The forge fires not occupied with steam hammer work will be used for ordinary hand forging, tool forging, tool dressing, tempering, and similar work. Where much tempering of special work is necessary, that is, when a large number of pieces of the regular product of the plant is to be so treated, special arrangements as to heating furnaces, dipping baths, etc., must be provided, and in many cases special automatic heating and hardening furnaces are employed. Obviously, the great variety of this class of work precludes a detailed description in this article.

Near the end wall, at the rear, is located an annealing and casehardening furnace of ample capacity. As this will be built on the premises, and as information in reference to its requirements and its construction may not be readily available, drawings have been made showing the details of its construction and giving all necessary dimensions. While this is for a furnace of quite large capacity for a machine shop plant, a smaller one may be readily constructed on proportionate dimensions, with good and practical results. If it is to be of, say, one-half these dimensions, or one-fourth the capacity, the lower heating ducts will be single instead of double, and it will be preferable to build it with a cast-iron casing inclosing all four sides, forming the door frames, and the separate pieces being bolted together at the corners, instead of having the brickwork held together by binders and rods as shown in the drawings.

The construction is clearly shown in Figs. 2, 3 and 4, being respectively a front, side and a rear elevation. Fig. 5 is a cross-section through the firebox *A*, showing the bridge wall *B*, the form of the covering arch *F*, and the position of the blast pipe *G*. Fig. 6 is a longitudinal section showing the firebox *A*, heating chamber *C*, heating ducts *D*, *D*, and sections of the front and rear doors. Fig 7 is a cross-section through the heating chamber *C*, the heating ducts *D*, *D*, dividing wall *M*, and the main door *N*. The foundation should be laid deep enough to support the weight of the furnace and its charge, and will be quite similar to that provided for boiler settings. The shaded portions indicate fire bricks, the balance being ordinary, hard, red bricks. The grate bars are of any convenient pattern, but must have ample air spaces so as not to impede the air blast delivered through the blast pipe *G*. The top arch is of fire brick and is carried all the way through both front and back walls, for convenience in making repairs upon it. The floor of the heating chamber is composed of fire brick tiles five inches thick, nine inches wide and twenty-four inches long, their outer ends supported by the inwardly projecting side walls, and their inner ends by the dividing wall *M*. They are laid about an inch apart so as to permit the gases and smoke to pass down between them to the heating ducts *D*, *D*, and out through the smoke pipe attached to the rear door *L*. The frame and door of the firebox are from the same pattern as the rear door *K*, while the frame of the ash pit door *J*, and the smoke door *L*, are from the same pattern. The doors are different, of course, as the door *L* must be provided with a circular sleeve to which the smoke pipe is attached, its other end connecting with the nearest chimney. The main door N, through which the annealing boxes are introduced, and removed, is of special construction and fitted with a fire brick lining, perforated by a circular opening or "peek hole," and held in place by four bolts (as shown in Fig. 3), which pass through iron straps on the inside of the fire brick lining. The stopper P is of tubular form and has an inwardly-projecting flange at its inner end for the purpose of holding the lining, which is composed of fire clay packed in as solidly as possible while it is slightly wet. This stopper may be removed at any time to obtain a view of the interior of the heating chamber and its contents during a heat, as all the doors are tightly closed and the cracks fluted with fire clay as soon as the fire is well under way, one charge of coal being usually sufficient for the heat after the furnace has been heated up.

The blast pipe furnishing the blast for the forges will also supply this furnace, the pressure required being the same, and will be connected to the fixture G located in the wall of the ash pit for that purpose.

Such a furnace as has just been described will, if properly built, and with occasional repairs to the fire brick lining, last many years. The writer knows of one which was built twenty years ago that is in serviceable condition at the present time.

On the opposite side of the central columns is located the group of machines for roughing out stock, the first being a heavy cutting-off machine capable of taking in stock up to six inches in diameter and cutting it off to any required length. In this machine there should be two tools fed automatically, and the machine should be provided with a convenient speed changing device whereby the surface cutting speed may be maintained constant at all diameters, as this latter feature will materially increase the output of the machine.

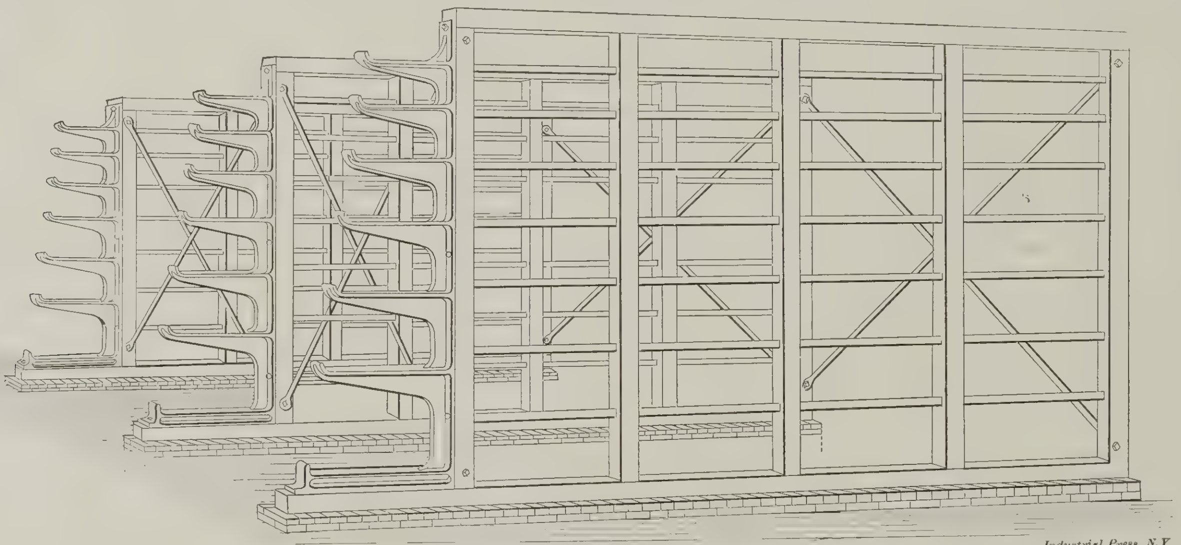
Industrial Press, N.Y.

Fig. 8. Rack for Bar Stock, for Storing Long Bars of Iron and Steel.

Next to this machine are two cutting-off machines of a capacity for four-inch stock and arranged similarly to the larger machine. They are so placed as to be conveniently operated by one man.

Next to these machines are two power hack saws, provided for cutting off square and flat stock. These should carry from twelve to fifteen-inch saws, and while apparently slow-working machines, are capable of cutting off a large quantity of stock in proportion to the labor cost of attendance.

Located near the large cutting-off machine is the cold saw, which will serve for stock or forgings beyond the capacity of the cutting-off machine or the power hack saws, and will often save much valuable time in finishing up a forging. The saws in these machines are from twelve to forty inches in diameter, the former size cutting off stock up to three and a half inches in diameter, and the latter handling thirteen-inch stock. For this case the saw should be twenty inches in diameter, and capable of cutting off seven and a half inch stock. There are many of these saws in the market and apparently not very much choice between them, all conditions being considered.

The shear, located next to the cold saw is not generally as much used as before the power hack saw came into notice, yet in certain classes of rough work it is very useful and operates quickly. It should be able to cut off round stock up to one inch, square stock to the same size, and flat stock to a half inch by two.

In the heavy turret lathe much work may be roughed out from the bar and sent to the machine shop in a more satisfactory condition than if it had been forged, and at the same time it will do the work more economically. It should take in stock up to three inches in diameter and be provided with a heavy, open, hexagonal turret, bored so as to allow the stock to pass entirely through it if necessary. It should also be provided with heavy roughing tools somewhat similar to box tools, as well as a heavy cutting-off slide adjustably supported on the bed.

The forge lathe, located next to the turret lathe, will be useful in rough-turning spindles and similar heavy work, and doing it much cheaper than forging the work down to close dimensions. It should be built for cuts of six or eight to the inch, and a cutting speed from one hundred feet per minute and slower.

A short work bench and vise is provided at each end of the line of forges for the convenience of the blacksmiths, and a much longer one on the opposite side for the men running the machine tools, which should have three vises upon it.

A supply of steam will be needed for the steam hammers, and may be brought from the power house in a conduit, the pipes being properly protected by a non-conducting covering to prevent, as far as possible, the loss of heat. But these hammers may be operated by compressed air, which will not be subjected to such loss. And as power will be required to run the line shafting driving the various machines it may be more economical to bring in a current of electricity with which to drive one or more motors, by which the line shafting may be driven and from which a small air compressor may be operated, thus bringing the power within the building and under the control of the foreman in charge of it. This plan would seem more advisable than the other. If an air compressor is used it may be located between the shear and the scale, and the reservoir connected with it placed directly overhead.

If an electric motor is used to drive the line shaft it will be convenient to place it overhead and near the center of the shaft, on a platform erected for the purpose, rather than to place it on the floor level, where it will be subjected to dirt and accidental injury.

A jib crane may be erected to serve the large steam hammer and an overhead trolley for the smaller one, the latter being the more economical of the two, and will be found nearly as convenient for comparatively light weights. The I-beams carrying the trolley and hoist should run from a point nearly over the center of the forge to a point close to the left side of the hammer, as seen on the plan.

Pneumatic hoists may be conveniently used not only on this trolley but in a similar way at the forge lathe and over some of the other machines for handling heavy bars. They work quickly, are easily handled, and when necessary may be readily moved from place to place.

The space for bar stock is located conveniently to the railroad track and the tram car track, and contains two racks for bar stock, the larger one for full length bars of iron and machine steel, and the smaller one for ordinary cast steel and tool steel bars. The larger of these racks is shown in perspective in Fig. 8. This is constructed of oak timbers formed into a rectangular frame, strongly bolted together and resting on good foundations capable of supporting the heavy weights of stock likely to be placed in the racks. Three of these frames are erected, six or seven feet apart and braced by cross-braces as shown. The timbers should be six inches square and provided with iron supports for the bar stock. These should be spaced further apart at the bottom than at the top, the bottom space being, say, fifteen inches, and the top space eight inches, center to center of cross bars. These supports should be flat, say, five-eighths by one and a half inch for the upper three; for the next two, three-quarters by one and three-quarters; and the two lower ones, one inch by two. It may be preferred to make the three or four lower supports of one and three-eighths-inch round steel, upon which are placed pieces of one and a half-inch gas pipe, turning freely, and so facilitating the running in and out of heavy bars. As seen in the engraving, the right-hand end of the frames may be securely bolted to the brick walls, and the cross-braces on this end be omitted. At the opposite, or front end of the frames, the sill timber projects from the front of the frame about three feet, and upon this are erected heavy cast-iron supports, of the form shown, which will be found very convenient for holding heavy bars, as they are open at the front, and bars may be readily lifted from the tram cars to them. Experience has shown this to be a very convenient, useful and substantial form of bar stock rack. In place of wooden timbers cast-iron supports may be used, but the cost will be much greater and the results not enough better to compensate for the added expense.

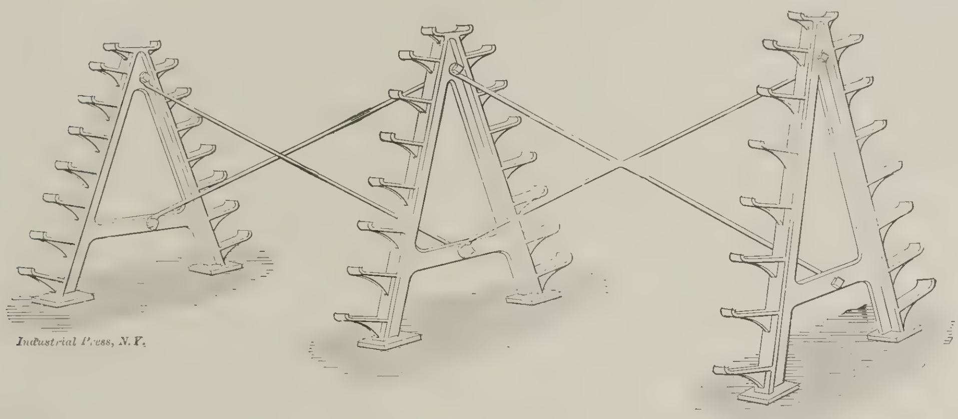

Fig. 9. Small Rack for Ordinary Cast-steel and Tool-steel Bars.

The smaller rack is built on the same plan, and may be constructed with or without the cast-iron racks in front of it. It should have substantial cross-braces between its frames, and also be securely braced from the brick wall.

For a shop rack the form shown in Fig. 9 will be found very convenient. The A-shaped supports are of cast iron, securely braced by cross-braces bolted on as shown. The base of the supports might be made relatively narrower than shown in the drawing without endangering their stability. Such a rack may be made of any number of supports and placed at any desired intervals apart that the work may require. Once we have the pattern, we may make as many castings as we choose and arrange them to suit any existing conditions. Usually they should not be over five feet high, unless rather small and light stock is to be placed on the upper supports. The lower projecting supports may be about ten inches long and the top ones about seven inches.

The wash room is located in one of the rear corners, and in connection with the water closets, which open out of it. A single wash sink of similar construction to the one illustrated and described in the article on foundry equipment is provided, and the individual lockers for the use of the men, and built of expanded metal, are arranged on both sides of the room in the usual manner. In the water closets six urinals and four closet seats are provided, the latter protected by double-hinged swinging doors, and the former separated by dividing partitions two feet wide. Both should be provided with an ample supply of water for automatically flushing them. The windows lighting the wash room and water closets are placed high enough in the wall so as not to interfere with the lockers or the urinals.

By the plans herein given all of the requirements of the operatives are placed conveniently within the building, so that whether for stock, fuel, or any reasonable cause, there is no necessity of leaving the building, as it is a well-known fact that men working near artificial heat, as do those at forges, are very sensitive to both heat and cold out of doors.

* * *

DURANGO'S IRON MOUNTAIN.

This solid mass of iron ore, close to the International Railroad depot at Durango, has figured in story and fable ever since the Spaniards and the Mexicans from the south first reclaimed this region from savages akin to the Apaches, over three hundred years ago. Geologically, examination shows it to be a very remarkable "dike," emerging from a rocky plain at the elevation of 6,300 feet, rising from 400 to 650 feet in height itself and forming a tremendous lump of iron ore 1 mile long and one-third of a mile wide. It has been calculated to contain 500,000,000 to 660,000,000 gross tons above the surface, with no notion of what may be below. The ore is a hard specular hematite, carrying on an average 60 per cent. of metallic iron, much of it going higher and some even to 67 per cent. It is suitable for practically all processes of iron and steel making.

One might think that such a property as this, where "mining" consists simply in knocking down the sides of a mountain to obtain a rich iron ore, in a country whose industrial expansion is demanding larger and larger importations of iron and steel, would be better than the best proverbial bonanza of gold. The fact is, however, that the Mexican National Iron and Steel Company, an American concern, whose mining claims cover about one-half the mountain, has never until lately been a paying concern. This seems to have been due, first, to the fact that it was formerly operated with a view solely or primarily to sale of stocks, and, in the second place, to the difficulties in securing at a reasonable price fuel with which to operate it on a paying basis. Charcoal can be obtained near here, made from the timber on the Sierras to the westward, but its production has always been limited and relatively expensive. Coke was formerly brought from the United States and at such prices that the marketing of the company's iron products in Mexico, except at near-by points, was, when the high freight rates were added, very commonly at a loss, or no gain, in competition with American iron products. As stated, Mexican coke is now obtained and at considerably lower prices. Moreover, the concern is being managed primarily as a business enterprise. Facilities are being added for an increased output, and everything augurs great prosperity for this institution, which now turns out in its foundry and machine shops steam engines, hoisting machinery for mines, stoves, and simpler products, such as nails, as well as bar iron. The steel plant, which the company's name implies, may soon be added.—*Consular Report, No. 1812.*

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The total value of American machinery and tools imported into Switzerland during the first six months of 1903 was $107,000.

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Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.

LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

FEBRUARY, 1904.

NET CIRCULATION FOR JANUARY, 1904,—26,694 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

SUGGESTIONS THAT HELP.

As a matter of course the editors of a technical journal receive a great many inquiries from subscribers, asking for information upon various subjects. In our own field we endeavor to give the information desired, either through the "How and Why" department, or if the subject is not of general interest, by referring the inquirer to some text-book or article which will tell him what he wants to know. We do not consider it within the province of a technical journal to devote space to matter that can easily be found in the ordinary books of reference, and thus take room that should be devoted to more timely matter of current interest.

Probably the readers of MACHINERY do not fully appreciate that such letters of inquiry are frequently of great service to the editors, in that they suggest topics for articles upon which published information is apparently lacking. A case in point is a contribution this month by Mr. Herbert E. Field, upon compositions and bronzes. A subscriber wrote us that he had tried to produce a very strong alloy by following Prof. Thurston's well-known formula of 55 per cent. copper, 42.5 per cent. zinc and 5 per cent. tin. According to Prof. Thurston a bronze of this mixture had shown under test a tensile strength of 68,000 pounds per square inch, yet our correspondent had not been able to produce a casting of over half this strength. Investigation showed that while handbooks contained statements of proportions for mixtures for alloys, nothing was said in any of them about the methods of mixing, melting and pouring to produce the best results; and it was at once evident to us that an article on this subject, telling what a man who had to make very strong bronze castings would want to know, would be of assistance to many readers, although this had not occurred to us previous to receiving the inquiry.

Another instance is a contribution in a recent number upon the coloring of metals. This was written as the direct result of an inquiry by a subscriber who could not obtain information about the best methods for producing blue, black, brown and other colors on steel, brass and copper. We found that very little had been written upon this, and that what had appeared was not fully treated, and so arranged for the article in question.

We should like to have these two instances of how subscribers have assisted us in securing interesting or valuable articles, serve as a hint to others, and accordingly ask any to write us, who are seeking information upon subjects which they believe would prove of interest to others as well as to themselves, if presented in the columns of MACHINERY. We believe we can render additional service to our readers in this way, as we have on file the names of specialists who are qualified to write authoritatively upon many branches of shopwork, machine design, and kindred topics.

Do not hesitate to send us suggestions.

* * *

IS THIS GENERAL ENGLISH PRACTICE?

The American machine tool builder who goes to Europe to introduce his product should be prepared for some surprises, agreeable and otherwise. In locomotive shops, for instance, he will very likely be impressed with the fact that in Europe locomotives are better built than in America—in a certain sense. They are highly finished, closely fitted, and generally designed for long service—how long, depends on the traditions and sentiments that eventually attach to many locomotives. But in the machine shop practice he will undoubtedly find some features not so pleasing. A gentleman, who recently visited Europe in the interest of the machine tool business, says that drilled and reamed centers in lathe work are practically unknown in many English shops. The standard taper of American lathe centers is 60 degrees; that of English lathe centers is 90 degrees (or thereabouts). As will be inferred from the foregoing, the reason for using such blunt centers is the very good one, or rather the very bad one, that all small and medium-sized work is centered with the prick-punch. The centers are *worn* into the work by heavy pressure applied on the tailstock. In fact the common practice is to put the work between the centers and screw up *hard* on the tailstock spindle for a few moments with the work revolving; then reverse the work and treat the opposite end in the same manner. Of course no 60-degree center will stand such treatment. And the 90-degree centers are found there worn into all kinds of fantastic shapes, approximating the Schiele curve, so-called.

The foregoing, relative to lathe centers, has a serious commercial aspect to the American machine tool builder when it is found to interfere with the production of accurate work. From one English shop in which a universal grinding machine had been installed, a complaint was sent that the machine did not grind work with the accuracy guaranteed by the makers. Investigation showed that the prick-punch method of centering was also being used on the grinding machine work! The suggestion was gently made that the centers should be nicely drilled and reamed to an angle of 60 degrees to fit the centers on the machine. Objection was raised that the shop had no facilities for doing this, but after some argument some Slocomb combination center drills were produced, though the proprietor insisted that they had never been able to make the "American gimcrack" work satisfactorily—that they invariably broke before the center was reamed to the proper depth. Further investigation along the line revealed that the spindle of the machine used for the purpose ran at only about 80 revolutions per minute. It was pointed out that it should run fully twenty times as fast, and when this change was made the troubles of center reaming and grinding were cured.

* * *

One of the surprising experiences of the writer has been that of visiting the plant of an old, well-known manufacturing concern and finding in what an out-of-the-way place it is located. Not as regards the town, but the site of the works—down in a narrow gorge, exposed to damage by floods and remote from the railway so that all supplies and product have to be hauled, at heavy expense, by teams. The reason for such a location, of course, is not far to seek; it was the water power, and in early years cheap power meant a great commercial advantage, perhaps more than now for many industries. Thanks to electrical transmission of power all these water powers can be made useful without placing the actual location of the plant where it is difficult to get at; it may now, in most cases, at once enjoy the commercial advantages of water power and convenient location to lines of travel. This condition is recognized to the extent that old water powers which had fallen into disuse, are being resurrected and made to turn the wheels of industry miles away. In a paper "The Influence of Electricity on the Development of Water Powers," read before the last semi-annual meeting of the New England Cotton Manufacturers' Association by Mr. F. A. C. Perrine, attention is called to this changed condition of affairs as regards water power for cotton mills. Mr. Perrine, however, expresses the belief that as a general proposition it does not pay to develop a water power where the first cost exceeds $300 per horse power for continuous power, and $200 for variable power, which makes the installation of a steam plant necessary for slack water periods.

* * *

THE DANGEROUS AUTOMOBILE.

That automobiles, or rather those racing machines which are the outgrowth of speed madness, can be built to run at great speed—equal to that of the locomotive even, has been quite amply demonstrated during the past year or two—quite too well in fact for the peace of mind and physical well-being of other road users. The latest exploit is that of whom the New York *Times* is pleased to call "a young speed maniac," who succeeded in covering one mile in 39.4 seconds on the ice of Lake St. Clair near Detroit, Mich. The ice was cleared of snow for a distance of five miles in a straightaway course. Hot cinders and sand were then spread on the course to a depth of one-half inch. This was cleared off as much as possible before the test was made. Notwithstanding the almost ideal conditions for fast speed the run was attended with great excitement and hazard for the chauffeur. What the mortality would have been if the course had been a country road lined with spectators it would not be pleasant to contemplate. The *Times* concludes an editorial comment with the following scathing arraignment of high speed machines in general:

> "Machines capable of a fraction of the speed attained at Detroit should be subject to indictment as public nuisances even when standing in the shed. They are to be classed with infernal machines, spring guns, mantraps, and other things in which reside the potentialities of manslaughter and homicide. Their manufacture promotes the end of the industry, by making necessary the enactment of even more stringent legislation than has yet been seriously proposed as the alternative of a recourse on the part of the public to summary measures of self-defense. It would be entirely proper, in the light of experience, to make the possession of a machine capable of materially exceeding the legal speed limit an offense of the kind committed in the carrying of concealed deadly weapons. To own a kit of burglar's tools is a crime, even though the owner cannot be shown to have used them burglariously. To carry hidden weapons is a misdemeanor, even though the possessor is to all appearance peaceably inclined. An automobile which can be run at dangerous speed sooner or later will be so run. If its owner has too much self-respect or respect for others to abuse it, some servant will do this the moment his back is turned. There is something in human nature which cannot resist the temptation to go fast when the means are at hand; and, curiously, those want to go fastest whose time is worth least."

* * *

THE DATA SHEET FOR FEBRUARY.

The data sheet for this month is planned to be of assistance to the designer in computing the weights of parts and for general estimating purposes. The first table presents a diagram of the weight of sheet metal for different thicknesses, both in metric and English measurements. In this country and in Europe thousands of tons of metal are sold annually by the weight per square foot, as this is considered more convenient and reliable than any other form of measurement, since owing to the operation of the rolls it is difficult to caliper the metal accurately by the edges, as the center is often thicker. In shipbuilding particularly the metal is specified in weight in pounds per square inch. In Europe material is commonly specified by thickness in millimeters and by the weight in kilograms per square meter. This table is arranged with a view of convenience in changing from one method of measurement to any other.

On the left hand side of the diagram the weight of sheets of various metals for a given thickness is given in kilograms per square meter, while on the opposite, or right-hand side, is given the weight of the same sheets in pounds per square foot. At the top of the diagram is given a scale of the thickness of a sheet in millimeters, while at the bottom is, first, a scale of 1¼ inch in hundredths and a corresponding scale in 64ths of an inch; next a scale of the thickness in United States Standard gage, while below is the same in Birmingham wire gage. Thus the diagram not only shows at a glance the weight in pounds per square foot, or in kilograms per square meter, but it also answers as a conversion table for the weight of sheets designated in any one system of units to any other units desired.

Table 2 gives the approximate weight of cast iron gears from 12 to 144 inches in diameter and having cast teeth from 1 inch to 6 inches circular pitch. These weights are the average of over four thousand standard gears that were weighed by the compiler during a period of four years. For estimations where the exact weight is not required the results derived from this table will be found to be quite accurate enough for all ordinary purposes. The figures given are for one inch of face and, for obtaining the weight of any gear, it is only necessary to multiply the number under the required diameter and pitch by the number of inches of face.

Table 3 gives the areas, circumferences and weights of the commercial sizes of cold-rolled shafting. For the weights here given we are indebted to the Jones & Laughlins Company, Pittsburg, Pa.

Page 4 comprises four tables, the first of which gives the weight of cast iron per superficial foot for various thicknesses. The second table gives the weight of nuts and bolt heads, and will be found useful when figuring the weight of long bolts. In this case the length of bolt under the head would be figured as a bar of given diameter and length and to this result would be added the weight given in the table for the nut and head. The last table gives the weight per cubic inch and per cubic foot of nearly all of the common metals and alloys and their specific gravities.

* * *

LARGE UNIVERSAL CHUCK.

What is undoubtedly the heaviest universal chuck ever built, in this country at least, was constructed last summer at the works of the R. D. Nuttall Company, Pittsburg. The diameter of the faceplate is 132 inches and its weight is 34,600 pounds. It carries eight jaws which are operated simultaneously by a ring bevel gear containing 266 teeth 2 diametral pitch and 2½ inches face. These teeth engage the pinions on the screws, which have 14 teeth each. The gear ring also has 266 spur teeth 2 diametral pitch cut in its periphery for the spur pinion gear through which the ring and jaws are operated. The pinion gear is not mounted in the faceplate but is attached to the frame of the machine, provision being made for throwing it into gear when the jaws are opened or closed. The screws moving the jaws are 2½ inches diameter. The chuck is driven by a pinion working in an internal gear cut from the solid on the back of the faceplate. The teeth were cut by a Newton gear planer or slotter having a capacity up to 30 feet diameter. The internal gear contains 120 teeth 1 diametral pitch and 9 inches face.

* * *

HUMOR OF A STRIKE.

Two strikers were picketing the entrance of an alley during the strike at the factory of the Kellogg Switchboard and Supply Company in Chicago last May. A non-union man came out of the factory and started across the street. One of the strikers picked up a brick. As he looked at it an expression of disgust came over his face and he threw it down.

"Why didn't you throw it at that scab?" asked the other striker.

"Because it is a non-union brick."—*The World's Work.*

* * *

A simple method of finding the height of high interiors, is to use a toy balloon attached to a thread. When the balloon touches the roof or ceiling, the floor line is indicated on the thread by a knot and the length measured along a convenient horizontal plane. This method was successfully used in the measurement of the height of cavern roofs in the Mammoth Cave, Kentucky.

HIGH-SPEED TOOL STEEL TESTS.

We have received from the Lodge & Shipley Machine Tool Company, Cincinnati, O., a summary of the results of tests upon high-speed steels which have been conducted at their works. This company was one of the first to adopt the Taylor-White process for treating steels for high-speed tools and have since tried nearly every high-speed steel that has been placed upon the market. While testing one of their high-speed lathes, which was designed to meet the new conditions brought about by these new steels, the experiments referred to were made with a view to finding the relative value of the several steels offered by different dealers, what speed limit it was possible to maintain with each, what the breaking-down points were, etc. The lathe used was a Lodge and Shipley 20-inch equipped with high-speed head, tailstock and double tool rest. The spindle is exclusively gear driven with two changes of speed, the ratios from pulley to spindle being 3.1 and 9.1, secured by sliding gears operated by a handwheel in front of the headstock. The tailstock is massive, and held to the shears by four bolts running through to the top. The carriage is equipped with two plain rests, both operated by telescoping screws and the same handwheel, which has a clutch in each end of the hub to engage with either front or back rest screw, as may be desired. The front tool rest has a transverse adjustment to permit easy setting of the tools and the dividing up of the cut when necessary. The power was derived through a 6-inch belt from a No. 3 Chard variator mounted on the ceiling and belted from lineshaft. This variator gives eight changes of speed, secured instantly without stopping the lathe. With the constant shaft running at 235 revolutions per minute, 637, 506, 376, 272, 200, 146, 108 and 85 revolutions per minute were secured at the variable shaft of the variator.

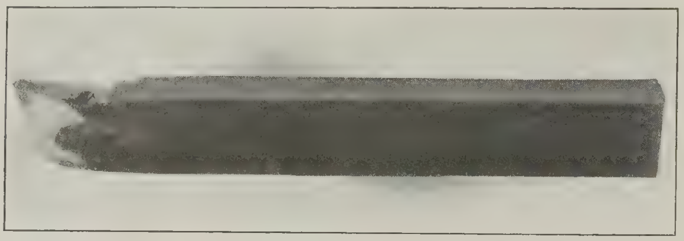

Fig. 1. Condition of Lathe Tool after Tests were Made.

Seven brands of steel were selected for tools and labeled from A to G, respectively. Several tools of each were made, all alike, and the different tools of each brand were indicated by numbers.

Limit tests were made with a 5⅛ diameter bar of machine steel containing about 0.18 per cent. carbon. Preliminary tests were made while removing scale to determine in about what order the tools might stand so as to give the better ones the higher speeds. Cuts of ⅛ depth by 1-20 feed were then made, and here tool A-2 with a cutting speed of 201 feet per minute cut a total distance of 14¼ inches without breaking down. Its nearest competitor was a tool which ran 6 inches at a speed of 180 feet per minute, the others ranging from 1½ to 5 inches at a cutting speed of about 190 feet. The bar was then turned round and a light cut taken over it at a depth of 1-32 inch by 1-40 inch feed. Tool A-2 again led, running 25 inches at a cutting speed of 361 feet per minute. The next best was a tool which ran 18 inches at a speed of 305 feet. The balance ranged from ½ inch to 6 inches.

Tests on cast-iron were then made, using a casting 8 inches in diameter and 12 inches long, clean of sand, and of about medium grade iron. After removing the scale light cut tests were run with 1-20 feed and 1-16 depth of cut, at 184 feet surface speed. Here some of the tools broke down instantly and most of the others did but little better, tool A-2 being the only one which ran across the casting, and one other ran 2⅛ inches. With a medium cut of 1-10 feed and ⅛ depth and about 1-19 surface speed most of the tools made a little better showing, although several broke down at once. Here again A-2 made a record of 15 inches. One of the B brand tools made the best showing of the balance, with two of the tools of the A brand falling in the rear but still leading the others.

The result of these tests shows that brand A, of air-hardening steel, tempered at a high heat in oil, is far superior to the others. All of the tests were run dry.

These trials were supplemented by several other endurance tests, using the two brands of steel showing the best records in the limit tests. Twenty-five back-gear sleeve forgings were selected, of about 0.18 carbon machine steel, and with from ¼ to ⅜ inch in diameter to be removed. This series was run with the tools wet, there being two tools, one in each rest, and the back tool removing only sufficient to keep under the skin of the forging most of the time. The body of the forging was 2⅞ inches diameter, with a large collar at one end and a total length of about two feet. Both tools required regrinding after finishing eight forgings, at a total of 152 feet longitudinal feed of tool at a surface speed of 169 feet. After regrinding the tools, seven pieces were finished when the back tool broke down, the front tool, however, being still in a very fair condition. They then tried a single tool, A-2, and finished nine pieces, or one more than the full run of the double tools, and found the tool still good for further use. The condition of the tool being somewhat interesting, it is shown in Fig. 1. The friction of the chip curling from the tool has worn a concave spot on top of the point, while there is no evidence of wear on the cutting edge. The outlasting of the single tool over the double, is attributed to hard spots in the forging, as in later tests on bar stock they have demonstrated a saving in the use of two tools.

Among other tests made was one upon a lot of back-gear forgings, similar to but larger than those mentioned above, in which the total time for handling and turning, by a lathe hand, unassisted, was 24 minutes, for eight forgings, or at the rate of 200 in 10 hours, although this rate could not have been maintained all day by the same man. The tool used was A brand steel, oil hardened, and was in good condition at the close of the experiment. Fig. 2 shows the forgings as rough-turned during the experiments. The larger pile contains 30 pieces rough-turned on the long end only and represents 1½ hours work had the same rate of speed been maintained for the lot as was recorded for the eight mentioned.

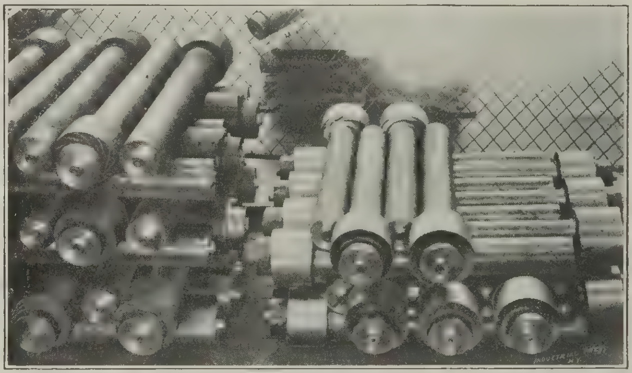

Fig. 2. Pile of Lathe Spindle Forgings Rough-turned during Experiments.

Another series of experiments were conducted to show the horse power consumed by the lathe and variator, while taking a cut at different speeds. It was quite clearly demonstrated during these tests that the higher speeds required much more power to remove a given amount of metal than the lower speeds and also that the angle of cutting edge of tool affected the power. With a depth of cut of 1-16 inch and feed of 2-15 inch about 18 horse power were required at a surface speed of 175 feet. With the same depth of cut and 1-10 inch feed about eight horse power were required, at 121 feet per minute. With depths of cut of ½ inch, feed 1-20, and speed 160 feet per minute, over 30 horse power were required, while at 128 feet only 19 horse power were necessary.

* * *

Articles of iron can be protected against iron rust by sinking them near the negative pole of an electric bath composed of ten liters of water, fifty grams of chloride of manganese and 200 grams of ammonium nitrate. Under the influence of the current the bath deposits on the articles a protecting film of metallic manganese.—*Mining World.*

THE RIEDLER-STUMPF STEAM TURBINE.*

AN IMPORTANT GERMAN WHEEL IN SUCCESSFUL USE.

"Extended study and experiment, in an entirely untried direction, having for their goal the overcoming of the many existing defects," writes Dr. Riedler, "have led Prof. Stumpf and myself to the creation of a new system of turbine construction."

The fundamental considerations were as follows:

From a purely dynamic standpoint the peripheral velocity of the wheel need be only half the velocity of the steam in order to gain the full force of the steam. This is the idea underlying De Laval's construction, which led to unserviceable rotary velocities and made the use of reducing gearing necessary. Therefore, in order to make any progress possible, while using the single or one step pressure effect and without essentially changing either the velocity of the steam or the peripheral velocity of the wheel, the following details must be technically accomplished:

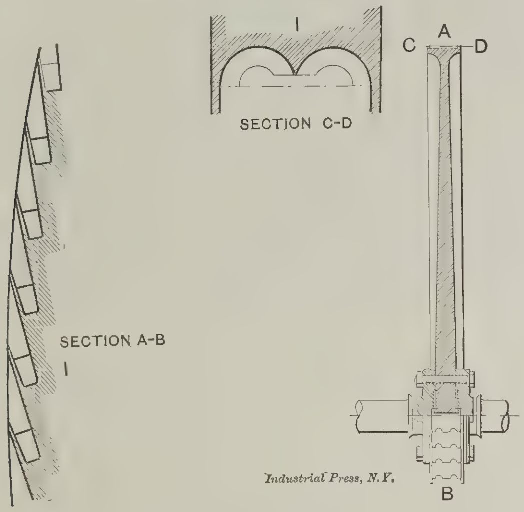

Fig. 1. Sections of Buckets.

1. When operating under the one step effect.—The diameter of the wheel should be so increased that with a practical speed of from 1500 to 3000 revolutions per minute, or just about 1-10 that of the velocity of the Laval turbine, the relative flow of the steam may be used to proper advantage.
2. By stepping down the velocity (compounding) the number of revolutions can be further reduced to 500 to 700 turns per minute for the many cases where such a velocity is deemed expedient.
3. The stepping down of both velocity and pressure is possible at one and the same time and by the application of a small number of pressure steps.
4. In all these cases, all the practical demands for proper construction and driving qualities are to be fully met.

The first essential is the increase in the diameter of the wheel and its relative shape in order to control the peripheral velocity without the use of gearing. Laval did not work in this direction and apparently thought it impracticable; he was therefore compelled to confine himself to the use of gearing and limit his power to small machines not exceeding 300 horse power. Large, rapidly revolving wheels having diameters from 2 to 3 meters, turning 1500 to 3000 times per minute, and giving a peripheral velocity of 1300 to 1700 feet per second, can be constructed with safety. They demand, however, proper use and application of the material and excellent workmanship as well as great care in the control of the dynamic forces. Such wheels have till now not been built.

To give the wheel its proper shape demands an exact calculation in advance, especially of the effects of centrifugal force, which, however, like all other calculations of material forces can be done with absolute certainty. It is further essential that for a predetermined velocity none other than the calculated material forces and their effects be permitted and that these effects should be uncommonly favorable.

The wheels are constructed as solid steel disks. The buckets are not set in but cut in the rim of the disk. The disk is smooth on its outer surface and rim, to lessen the frictional resistance of the steam. Such disks may be exactly balanced without difficulty, by simple means.

The centrifugal forces tax the disk most severely at the center of the wheel. For this reason the wheel disk is not bored out for the shaft but is bolted to a flange at one end of the shaft. Where this is not practical the disk is made with a wide boss at the center, which tapers off to the rim, maintaining a cross section, which answers all demands and makes fullest use of the material (see Fig. 1). Large wheels afford a more advantageous use of the material, and with equal velocity the safety of the disk, at least up to a fixed limit, increases with the diameter. This is easily proven by calculation. Wheels of 6½ feet diameter for 3,000 revolutions per minute may be built of nickel steel with a five-fold margin of safety. But a five-fold margin is not required, two-fold, or at most two-and-a-half-fold is quite sufficient.

Unlike all other mechanical forces the centrifugal force is in effect completely without jar and is continuous, being repeated at each point millions of times. And yet we are satisfied with small margins of safety, especially in locomotives and marine engines.

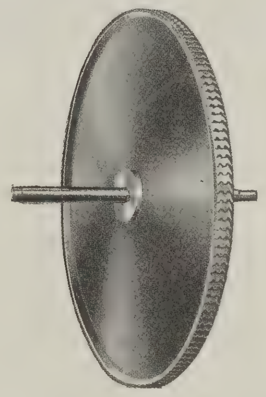

Fig. 2. Turbine Wheel Disk.

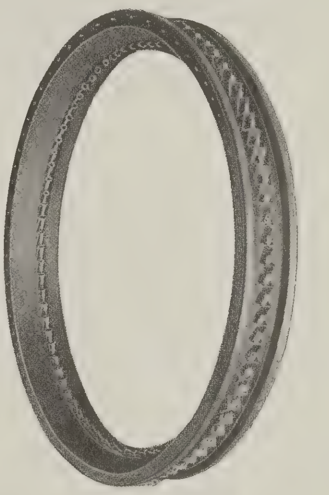

Fig. 3. Nozzle Ring.

The determinative point is the elastic limit or tensile strength of the material from which the wheel is made, at which permanent changes of form take place and should, of course, never be reached.

The first wheel built was made of nickel steel of 107,000 pounds tensile strength. This afforded a margin of safety four times greater than was theoretically required. Without danger then this might be reduced one-half.

When the extreme hardness of this material is considered the thought might well occur that there would be internal strains in the castings, more particularly in the heavier rim. To discover if such were possibly the case the first wheels were sawed across the rim, making many small slits in the periphery, and developments awaited. Should secondary tensions exist the telltale slits, by closing or widening, would disclose the conditions. Since, however, nothing of the sort followed there remained but to conclude that the castings were perfect inside and out. These slotted wheels were also driven at a velocity of 1000 feet per second without unfavorable results, which also proved that the original calculation, in spite of the weakening of the rim, provided for a sufficient margin of safety against the pull of the centrifugal force.

Different, too, from the mounting of the Laval wheels is the construction employed in setting up the Riedler-Stumpf turbines.

De Laval's pliable shaft would not answer for large, heavy, rapidly-moving wheels. To obtain any appreciable bend in the thicker shaft necessary to carry the heavier wheel, the bearings would require to be very far apart. Quite the con-

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[*] Abstract of paper read by Dr. A. Riedler, Berlin. Published by the Schiffbautechnische Gesellschaft, Berlin, and translated for MACHINERY by Chas. A. Brassler. The Riedler-Stumpf turbine is of the De Laval type, having expanding nozzles from which the steam issues in jets and impinges against the wheel blades. The buckets are similar in construction to those of the Pelton water wheel and the turbine is constructed either in one stage, like the De Laval, or in two or more stages, like the Curtis turbine.—EDITOR.

trary is the case here. The bearings are placed as close as possible to the wheel, so that any give in the shaft is next to zero.

However, the wheels are perfectly balanced upon the shaft, and the inexactitude of the center of gravity corrected to within 0.004 inch. By indefatigable exertion this state—the one in which they are delivered from the works—may be still further corrected to within 0.0004 inch.

The center of gravity of a wheel so carefully adjusted is so true that it will be impossible to exceed the critical velocity, and in fact will not be appreciated by anyone but the most experienced expert.

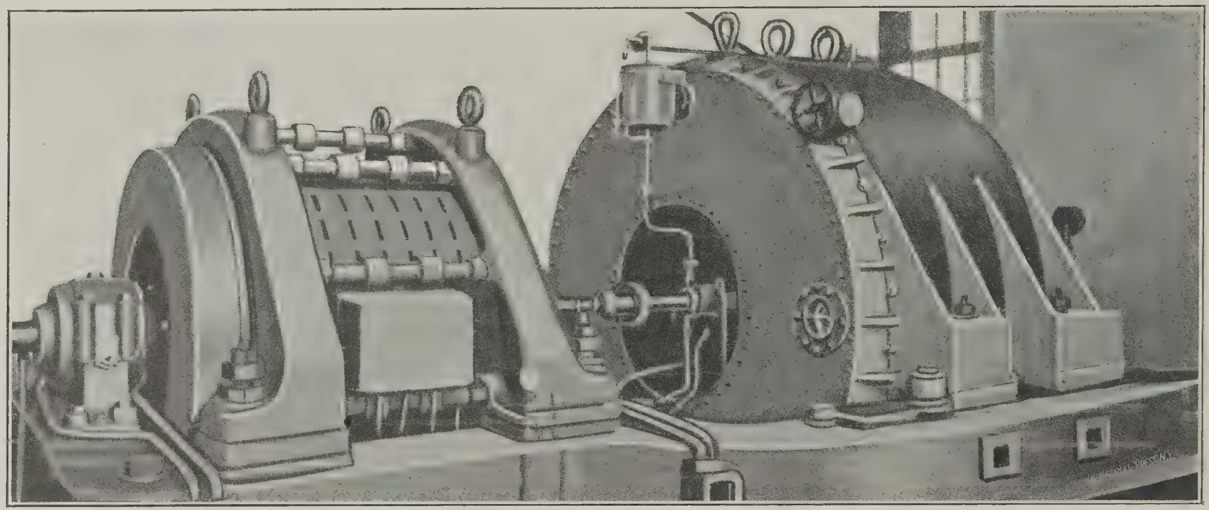


Fig. 4. Two-thousand H. P. Riedler-Stumpf Steam Turbine Direct-connected to Electric Generator.

Having exceeded the critical velocity the condition of dynamic equilibrium could only be found by a slight movement of the axis. For this purpose De Laval made his axis pliable, but in the balanced Stumpf turbine the slight motion of the shaft in its bearings is sufficient. The running of the shaft, even when turning 3,000 to 4,000 times a minute, is faultlessly quiet. The motion of the machine is neither sensible to the touch nor to the eye. Having reached such perfection in the wheel, it was an easy matter to simplify other accessories. As above stated the buckets are not set in, but cut in the solid rim, and these may be cut one, two, or more at a time on the milling machine. The resistance to ventilation is greatly improved or lessened by the overlapping, shingle-like construction of these buckets. If the power is not applied all around the inoperative parts may be uncovered by partitions, which lessen the resistance.

Having the buckets on the exterior of the rim affords a more advantageous adaptation of the nozzle angle; though the effective leverage of the wheel when in motion is slightly decreased thereby. Again, having the buckets on the top of the rim instead of on the side of the rim, as in the De Laval, permits the delivery of the full force of the cross section of the flowing power. In the De Laval nozzle the stream of steam strikes the wheel in an ellipse, whereas with square nozzles of the Riedler-Stumpf type, it strikes it in a solid square. In the former system the impact is uneven, being greater in the center of the ellipse than at its outer edges, whereas with the square stream impinging point blank upon the buckets cut in the outer rim of the wheel all parts of the buckets are attacked with equal force. The Riedler-Stumpf nozzles have a square cross section and lie close together and the steam flowing from them forms a completely closed ring of power. This arrangement makes it possible to surround the whole wheel with nozzles by which many losses may be avoided. The buckets, too, are like little pockets, and constructed either as single pockets in which the steam enters at one side, passes to the opposite side, and exits at an angle of 180 degrees; or they are double pockets with entrance at the middle and exit at the side. The Riedler-Stumpf buckets remind one of the Pelton wheels, though instead of following one behind the other, as in the Pelton, they are one above the other, in layers; nor are they set in, but instead are cut in the rim. Again the Pelton buckets are open on all sides. These are provided with walls which prevent the escape of the steam in any other than the desired direction. The water of the Pelton is not led away, but escapes as best it may, while in the case before us the steam is directed as well at its exit as at its entrance. No packing is needed on the interior of the wheel, as in the De Laval, and there is some considerable play between the rim of the wheel and the mouths of the nozzles. An increase of this distance to 0.2 inch has not shown any lessening on the pressure upon the buckets nor in the work accomplished. In the 2,000-horsepower wheel at Moabit, near Berlin, the radial distance between the nozzle and the bucket is 0.12 inch; in a tangential direction, 0.39 inch. Here we have no axial thrust as a consequence of the sidewise impact, which must be taken up in the De Laval by miter wheels, and in the Parsons by the compensating pistons. The wheels are made of steel and an admixture of 10 per cent. of nickel has been found the best to preserve them against the corrosive influence of rust. The principles of the peculiar shape of the nozzle were acquired by numerous experiments, which showed that form had a marked effect upon the degree of efficiency. In the nozzle the first important step is taken in the advantageous employment of the energy of the steam. It is here that the transition from expansion into flowing energy takes place. The desideratum is to obtain the generation of the maximum velocity as well as the proper leading of the stream.

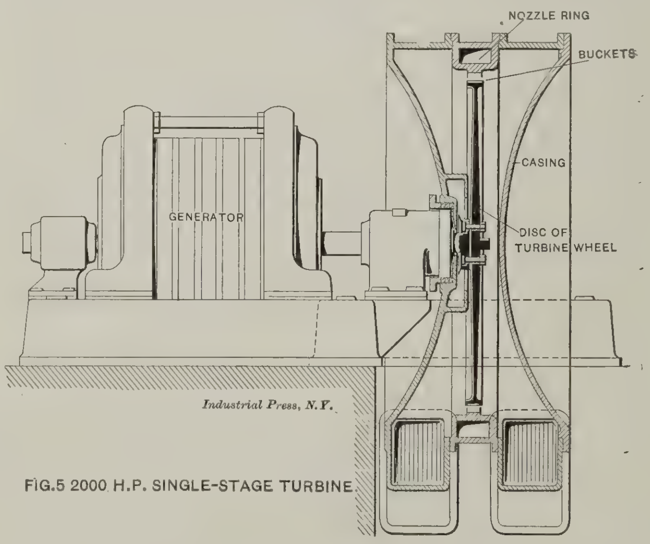


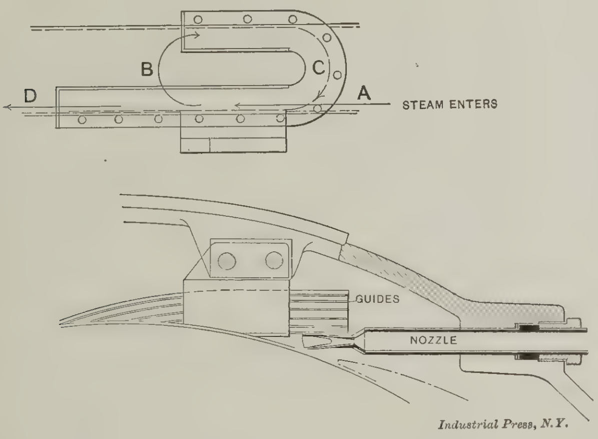
Fig. 5. Two-thousand H. P. Single-stage Turbine.

These demands are met by the construction of the nozzles, as shown, which are of easy construction, while the De Laval nozzles, with their elliptical openings do not offer the possibility of grouping them properly together and assuring a reliable leading of the streams of steam one under the other. In Fig. 3 we show a complete ring of nozzles as furnished in the 2,000-horsepower turbine in the electric plant at Moabit, near Berlin. In wheels of less power the nozzles are placed in a single group; in either case the regulation is such that the nozzles may be shut off one after the other from a central point.

The first 500-horsepower experimental turbine constructed is in the machinery department of the Technical High School. It consists of two wheels of 1.5 meters (5 feet) diameter. Where the steam is exhausted in the open air only one wheel is used; with a condenser and an intermediate chamber for changing the direction of the steam, both wheels come into requisition. The nozzle apparatus consists of two rings faced together, in one of which the nozzles are cut so that the single streams form a closed ring. Its first test was made with a hydraulic brake in the Technical High School. In the meantime the Allgemeine Elektrizitäts Gesellschaft constructed an alternating dynamo and they are now coupled together at work in the electric plant. Speeding at 3,000 turns per minute neither the turbine nor the dynamo showed the least vibration.

Using the nozzle apparatus which was arranged for condensation, but only one wheel, the consumption of steam was but 28.6 pounds per effective horse power.

The next wheel built was just four times as powerful and is shown in Fig. 4. It is a 2 000-horsepower turbine for the same electric plant. In building this machine, for the sake of simplicity, though to the disadvantage of the effective force, several losses were permitted. About 5 per cent. of the velocity at the nozzles and 15 per cent. in the shape of the buckets, and an effective loss of 15 per cent. in the intentionally exaggerated exit velocity with which the steam poured into the condenser. In spite of these defects, it was found to run with a consumption of 19.6 pounds of steam, later reduced to 17.6 pounds per kilowatt hour, which compares favorably with the best published statement (19.4) of the 1,500-horsepower Parsons turbine at Elberfeld. The working steam pressure was 195 pounds with a temperature of 294 degrees, though the vacuum was only 85 per cent., simply because the condenser at hand was not capable of producing better results. Now it is well known that the vacuum has a marked effect upon the consumption of steam, therefore with a 95 per cent. vacuum and the avoidance of the above-named losses the consumption can be brought down to 16.5 pounds per kilowatt hour. Again the exhaust losses can be diminished by increasing the diameter of the wheel from 2 meters to 3 meters (10 feet), which would bring the consumption further down to 14.3 pounds per kilowatt hour.



Industrial Press, N.Y.

Fig. 6. Method of Applying Steam twice to the same Set of Buckets.

The packing of the shaft at its exit from the casing is done by an oil bearing. At the outer extremity of the oil box is forced a stream of oil which is sucked in by the partial vacuum within, and by means of a system of points the oil is all caught up and carried out again with such economy that during the running no loss in oil was apparent. The small weight of the wheel, 850 kilograms, (about 1,800 pounds), makes the question of keeping the bearings in perfect condition a very simple one. The construction of the one step Riedler-Stumpf turbine is the simplest of all turbines, and it meets at the same time all requirements for accessibility and economical consumption of steam.

The high-speed (3,000 revolutions per minute) is in many cases admissible, especially for alternating current dynamos, blowers, compressors, pumps, etc.; but it is by no means essential to the perfect working of the turbine. The same simplicity prevails when the diameter of the wheel is increased, reducing the number of revolutions to 1,500 per minute, but maintaining the same peripheral velocity. Since it is easily within practical mechanics to construct and run one step turbines of 5 meters (16½ feet) diameter, such wheels are applicable to the driving of direct current dynamos. Fig. 5 is a sketch of a 2,000-horsepower Riedler-Stumpf turbine with a wheel having a speed of 3,000 revolutions. A wheel one meter larger in diameter would need to turn only half as fast to maintain the same peripheral velocity and deliver 5,000 kilowatts at the bus bars. In these huge dynamos the armature is so heavy that the shaft is strong enough to carry the wheel on the free end of the shaft close to the outboard bearing. The casing is therefore built around the pillow block, which thus serves a double purpose. All special bearings for the turbine are in this way eliminated, simplifying the construction still further. These wheels are built in one step, two, three, and four step forms. The stepping down of the velocity is the most effective way of reducing the number of revolutions, and this is done in two ways, one we have already shown by increasing the size of the wheel, the other by stepping down the pressure.

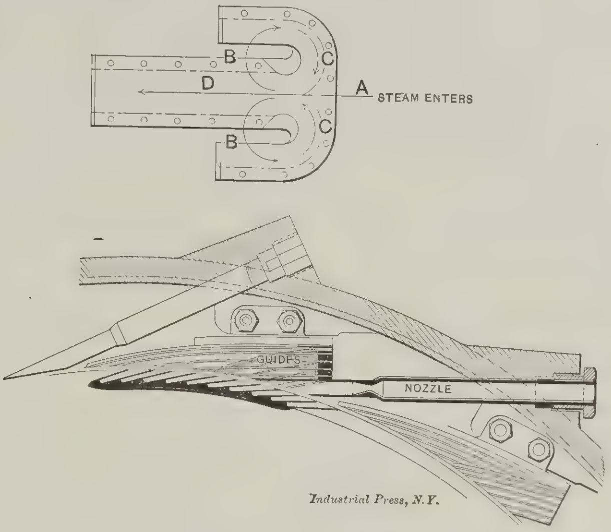


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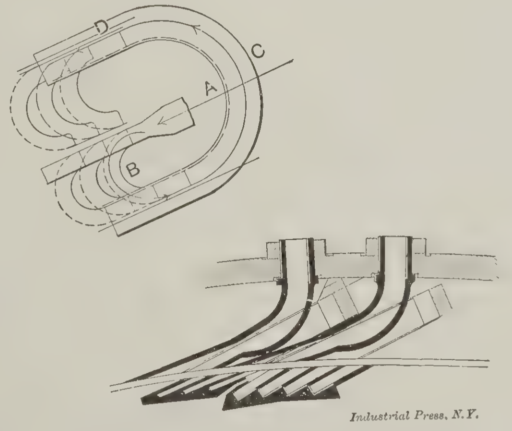
Fig. 7. Method of Applying Steam twice to the same Buckets when Buckets are of the Pelton Type.



Industrial Press, N.Y.

Fig. 8. Method of taking Steam from one Set of Buckets and Conveying it to a second Set in a Two-stage Machine.

This latter is accomplished by altering the form of the buckets so that with wheels of less diameter the current is made to turn completely around and re-enter the same row of buckets, or by throwing it out of line cause it to enter a neighboring row of buckets.

The formation of the guide passages to produce these results is shown in Figs. 6, 7 and 8. In Fig. 6 steam enters at *A*, at one side of the buckets, passes around the curved buckets of the wheel, as indicated by the arrows at *D*, and when it is discharged from the wheel buckets it enters the guide passages, is deflected at *C*, and finally enters the wheel buckets again at the point *D*.

Figs. 6 and 7 show the method of conducting steam from the buckets of the first wheel to a second row of buckets of another wheel parallel and on the same axis with the first one. In Fig. 7 buckets similar to those of the Pelton water wheel are used, steam impinging at their center and passing both to the right and left. It enters at *A*, is deflected by the buckets at *BB*, whence it enters the guide passages and is deflected again at *CC*, and finally it impinges against the same row of buckets again in the direction of the arrow *D*.

In Fig. 8 steam enters in the direction *A* at one side of buckets *BB*, where it is deflected and then passes around guide *C*, and finally impinges against another row of buckets in the direction *D*. In Fig. 9 is a sectional drawing of a two-stage turbine, similar in its arrangement to the Curtis turbine made in this country. The upper wheel may be classed as a high-pressure wheel and the lower a low-pressure wheel. Steam enters as indicated, and is conducted by suitable passages from the first to the second wheel. It then enters the annular passage *EE*, where it comes in contact with condensing water which enters through openings in the periphery of this passage. The mingled steam and water then flow to the center where they enter between the two rotating disks at *R*. The condensed steam and condensing water are here thrown upward by centrifugal force and are discharged through openings at *MM*. This novel arrangement of the condenser insures thorough intermingling of the water and steam and produces a high vacuum. The shaft of this turbine and generator instead of being carried on a step bearing at the bottom is supported by a bearing, *B*, situated between the turbine and the generator.

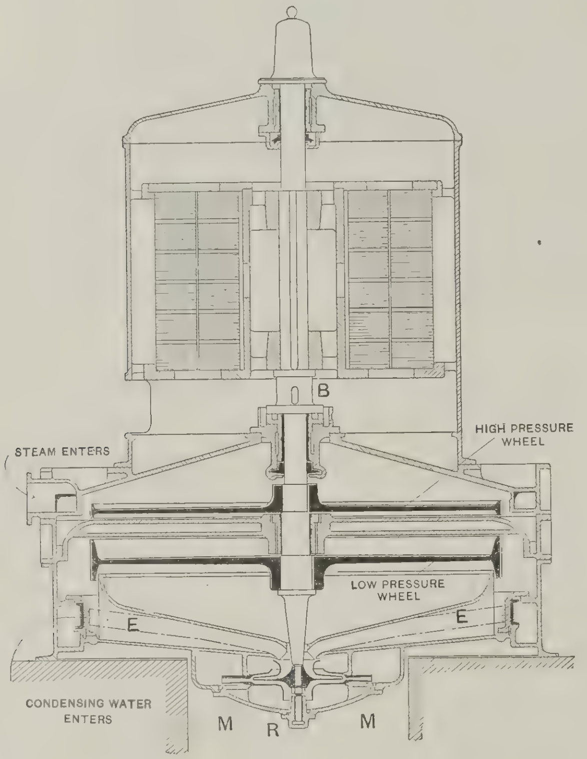


Fig. 9. Two-disk Machine with Vertical Axis.

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ALTERNATING CURRENT MOTORS FOR RAILWAY WORK—AMERICAN DEVELOPMENTS.

WM. BAXTER, JR.

The alternating current motor for traction work is receiving a great deal of attention at the present time and those actively engaged in its development are very sanguine as to its future. The motor which appears to be the best suited to this class of work is what is known as the commutator type. Several experimenters in Europe have been working to develop this form of machine, and it has received considerable attention in this country, the most noteworthy results having been achieved by Mr. B. G. Lamme, of the Westinghouse Company.

The commutator type of alternating current motor is a machine that is practically the same as the ordinary continuous current motor; in fact the only difference, structurally, is in the field core which is made laminated. The proportions of the various parts are somewhat modified, but the action is the same, and one of these motors will run fully as well with continuous as with alternating current; and in fact will give a trifle more power with continuous current of the same voltage and same number of amperes.

Commutator motors of the alternating current type have been made for years, but, up to recently, their performance has not been satisfactory—the efficiency and output being low, and the sparking at the commutator excessive. The motors that have been developed within the last few years are far superior to those previously made, in part because they have been designed to be operated by currents of much lower frequency, but principally because greater skill has been exercised in designing them.

Alternating current commutator motors for a given capacity are larger than continuous current motors, and are of a somewhat lower efficiency. The difference in efficiency is not very great, but in weight the difference is between fifteen and twenty per cent. This latter difference is due in part to the fact that the field coils must be much better insulated to withstand the inductive action of the current, and in part to the fact that the power developed is not equal to the product of the volts and the amperes, but is equal to a percentage of this product, equal to the power factor of the current.

Although the alternating current motor is heavier and of a slightly lower efficiency than the continuous current machine, the difference is not great, and in many cases can be more than offset by the reduced cost of installation. For long distance traction work, with continuous currents, the present practice is to use alternating currents to distribute the energy from the central station, and to provide a number of substations where, through rotary transformers, continuous currents are obtained to feed the trolley lines. As the rotary transformers are moving machines attendants must be provided at the substations. With alternating current motors, the rotary machines at the sub-stations can be replaced by static transformers that require no attendance. These transformers cost much less than the rotary machines, so that the cost of installation and the operating expense are both reduced; hence for long roads the alternating current motors appear to have a promising future. Its advocates claim that it can be shown to be more economical than the continuous current motor, even for city work, owing to the fact that the speed of the motor can be reduced without introducing resistance in the circuit, hence without wasting energy, as is the case with the continuous current motor. While it is true that this waste of energy could be obviated, it is by no means certain that the saving thereby effected would be enough to offset the increased weight of the motors.

The advocates of the alternating motor, to show as great an advantage for it as possible, claim that it could be used with much higher voltage than is now employed on the trolley lines, some of them running as high as 4,000 volts, which they propose to carry right to the car, where it would be passed through a transformer to obtain a low voltage secondary current to operate the motors. While by such means the cost of line wires could be greatly reduced, the danger of seriously injuring the passengers if the insulation failed would be so great that it is doubtful if many conservative engineers could be found who would be willing to indorse the plan. From present indications, however, the alternating current motor can make a place for itself in the railway field without resorting to such wild engineering as the transmission of 3,000 or 4,000 volt currents through the trolley wire, even much less their transmission directly to the car.

Besides the work of Mr. Lamme, of the Westinghouse Company, the most noteworthy attempt to use the single-phase alternating current is to be found in the Arnold system, in which both compressed air and electricity are employed. The motor is operated at constant speed under constant load, the means for increasing or diminishing the power required to operate the car being supplied by the compressed air. The electric motors thus have to be only large enough to propel the car and its machinery under average conditions, and when a given number of cars is in use the power house will operate under a uniform and constant load—quite an unusual condition in railroad work.

[The motor arrangement, as has already been explained in MACHINERY, is such that both the rotor and stator can revolve. One of these is geared to the car axle and both rotary elements are connected to an air engine which can act either as an air compressor or as a motor. By throttling one compressor it can be slowed down and as the rotor and stator must always run at the same speed relative to each other, the other compressor, together with its motor connection, will speed up accordingly, provided the demand for power is not above normal. If the demand is above normal, then one or both of the air engines acts as a motor, operated by the compressed air from the tanks. When the demand is below normal, air is compressed in the tanks by the air engines, which then act like compressors, and is thus in readiness for the next call for extra power. By thus manipulating the air engines, a greater or less degree of power is available for driving the car, as required, and the car can be run either faster or slower than the synchronous speed of the motor.

An important feature, due to the compressed air, is the fact that the car can be driven a short distance by compressed air alone, as in switching or through thickly populated districts, where the presence of a high tension current is objectionable. Mr. Arnold's work has been done in the vicinity of Chicago, and unfortunately his experimental car has recently been destroyed by fire; but another one is to be built.—Editor.]

* * *

THE SINGLE-PHASE MOTOR IN EUROPE.

DR. ALFRED GRADENWITZ.

The single-phase motor for electric traction is best developed in European practice in the motors of Dr. Finzi, of Milan, Italy, and of the Union Electric Company, of Berlin, Germany. The series single-phase motor designed by Dr. Finzi works at constant voltage, regulating its speed automatically, according to the load, the speed being inversely proportional to the latter for high values of the torque. It permits of voltage regulation without losses and of the speed being varied within very extensive limits. On the other hand it is not able to use high voltage directly and at present is bound to relatively low frequencies. Compared with continuous current motors it is found to require fewer watt hours per ton in starting, and the characteristic curves for the single-phase motor are very good indeed.

In November, 1903, a description of the Union Electric Company's motor was published in MACHINERY. Since then the results have come to hand of interesting experiments made by the Union Electric Company on the Spindlersfelde-Johannisthal electric line. This line has been in regular operation since the 15th of August, and has been inspected by a great number of German and foreign engineers. At the present time single motor cars, exclusively, are run; it is intended, however, to run trains made up of two motor-cars and trailers later on. The motor-car, including the whole of its equipment, weighs 52 tons, the electric equipment weighing 6 tons. It is fitted with two 125 horse power motors, mounted on the same rotary frame, one exciting system, and one controller at each end of the car. The car is so designed that any desired number may be coupled together and be operated by one guard. The current is collected by two short bows; automatic safety devices and fuses afford protection against excessively high currents. There is in addition a small transformer to supply current for the pneumatic pumps, as well as the controlling and lighting circuits. There are no shunt resistances.

The motors, constructed by the Union Elektricitäts Ges., according to Winter and Eichberg's data, are designed for a tension of 6,000 volts and for 25 cycles. They are permanently connected in series, and though their efficiency with full speed is, as a matter of course, somewhat less than the efficiency of direct-current motors, this advantage of the latter is offset by their great energy consumption in starting.

The trolley wire of the line conveys the electric energy at a tension of 6,000 volts, the running rails serving as a return circuit. The trolley wire shows some novel features, as instead of being supported by transverse wires the working wire is suspended from longitudinal wires in the form of nearly loose catenary curves. From these longitudinal wires, thin vertical wires are suspended at distances of about three meters, to support the working wire. Part of the track is fitted with one bearing wire, whereas the remainder has two such wires; experiment will show which is the better design. This arrangement of the working wire, where the latter has nearly no tension, will materially diminish the danger of breaking it, and as the suspension points are placed at distances not exceeding three meters, the consequences of a break are, at the same time, notably diminished, the end of a broken wire being beyond the reach of the railway *personnel*.

The Lamme and Dr. Finzi motors, being series motors which absorb immediately only tensions below 160 volts, the electric energy has to be reduced to this low tension. The motors designed by the Union Company can operate under any voltage, and are therefore connected directly with the primary circuit, with the exception of a small portion of the circuit, viz., about the sixth part of the energy, which is reduced to low tension. These advantages will result in small weights of the cars and an improvement in the efficiency, the first point being specially important in connection with narrow gage railways. The small gage railway motor of the Union Company is designed for 40 cycles, so that no difficulties will be met with in lighting the cars, as is the case with motors that operate with much lower frequencies. The greater advantage, however, is the fact that alternating current railways, according to the Union system, may be supplied direct from the same machines designed for supply of light and power, special plants and machines thus being unnecessary in the case of small gage railways for light traffic.

From these trial runs great consequences may be anticipated for the electric industry. In fact, in many cases where present systems are not able to afford sufficient saving to justify electrification the Union system is likely to be used advantageously on account of the absence of sub-stations, the lower cost of equipment of the line, and the high efficiency of the power transmission. The scheme will also be especially advantageous in connection with mountain railways, and long tunnel sections, metropolitan, as well as suburban.

* * *

LARGE WESTINGHOUSE-PARSONS TURBINES.

The Westinghouse-Parsons steam turbine was commercially introduced about four years ago in sizes of 600 horse power. Subsequent development has been so rapid that turbines of 5,500 kilowatts or 7,500 horse power, have been designed and are now under construction. A 5,000 kilowatt unit, of the same general type as these largest machines is illustrated herewith, and its distinguishing features are extreme compactness and low rotative speed. Machines of this type will form the initial equipment of the Pennsylvania Railroad Terminal property in New York City, operating the heavy Pullman trains through the tunnel approaches to Manhattan; and similar installations of turbines and generators are to be made in Philadelphia and London for street railway work.

The space occupied by the 7,500 horse power turbine is approximately 27 feet 8 inches by 13 feet 3 inches, and the height to the top of the hand railing is 12 feet. This is equivalent to .049 square foot (less than one-twentieth square foot) per electric horse power capacity, or 20.2 horse power per square foot of floor area required.

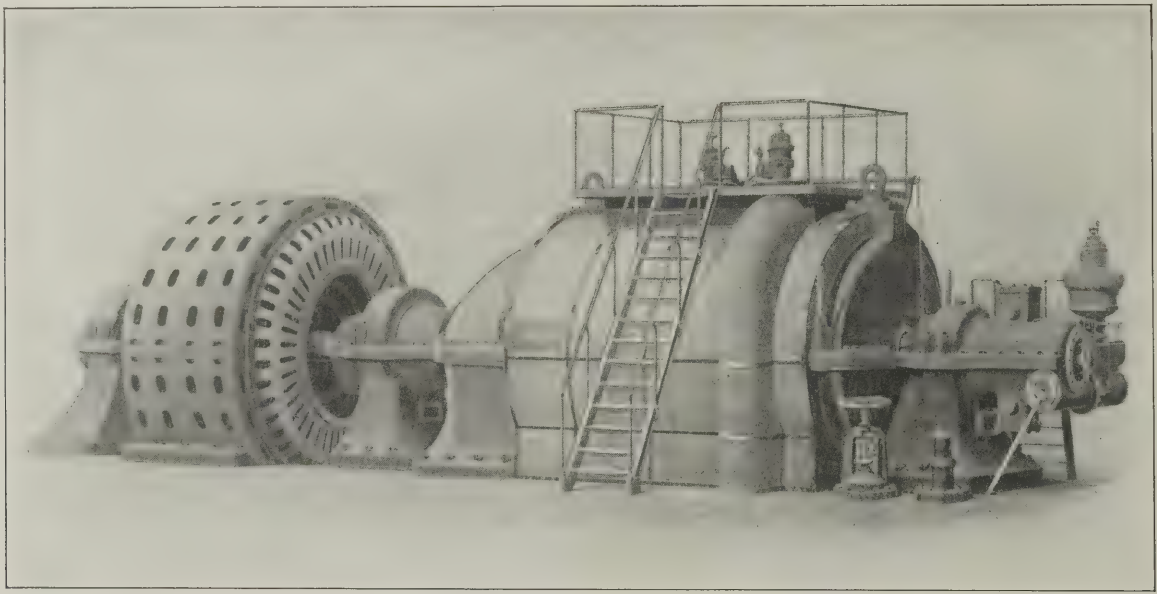
For the complete unit a rectangular area of 47 feet 4 inches in length and 13 feet 0 inches in width is required, which is equivalent to .084 square feet per E. H. P. capacity, or 12 E. H. P. per square foot of floor space. The 5,000 kilowatt units operate at 750 revolutions per minute, the 2,000 kilowatt unit 1,200 to 1,560 revolutions per minute, and the 1,000 kilowatt unit 1,500 to 1,800 revolutions per minute, depending upon the frequency desired.

In the new machines virtually the same general plan of construction and method of using the steam expansively have been retained that were employed in the earlier turbines, and which are very familiar to all readers of technical papers. The single horizontal drum which carries the turbine blades must, however, be supported with unusual rigidity in so large a machine and a novel form of shaft construction has been adopted. A central steel quill carries the entire central rotating parts.

Hollow forged steel ends are forced into the two ends of this quill, under hydraulic pressure, and are in addition secured by arrowhead links. High pressure steam is conveyea to all parts of this quill structure in such a manner as to eliminate stresses and consequent distortion due to highly superheated steam.

The journals in the larger machines are of the solid self-aligning type, similar to that employed in generators and cross-compound engines. The departure from the familiar oil-cushioned journal employed in the small machines is occasioned by the speed reduction secured. The journal shells are babbitt lined and are split horizontally, the two halves being united by bolts with shim adjustment. Oil from a central system is introduced at the center under slight pressure, thoroughly flushing all parts. The diameter of the shaft at the journal of a 5,000 kilowatt machine is 15 inches, strikingly small in comparison to the 34-inch shafts required for a cross-compound reciprocating engine of corresponding capacity.

An important feature of the steam distribution system is the provision of a by-pass valve. This valve admits high pressure steam to the second stage of the turbine on overloads in order to increase its capacity, up to 50 per cent. in excess of full rated load. By properly proportionating the by-pass steam to the overload on the turbine, maximum economy may at all times be secured together with reserve overload capacity. This results in a slight rise in the economy curve on heavy overloads, resembling in some respects the engine economy curve on loads exceeding that of maximum economy. The turbine, however, only suffers in economy at heavy overloads, while the engine economy decreases progressively from 75 to 80 per cent. of full load capacity.



Westinghouse-Parsons 5000 K.W. Generator for Pennsylvania Railroad Terminal, New York.

The main admission valve consists of a double-beat poppet valve operated by a small piston, this in turn being controlled by a small pilot valve directly actuated by the governor mechanism. The valve admits steam to the turbine in puffs, the duration of which is proportioned by the governor to the load upon the turbine. This intermittent method obviates the throttling of steam.

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A writer in *Sparks from the Anvil* refers to the alleged fact that steel will not harden in boiling water and says that the reason for this phenomenon is not apparent since it will harden at higher temperatures as he has proved. He has hardened a chisel in a bath of melted tin, the temperature of which is about 465 degrees F., so that it cannot be the mere heat of the boiling water that prevents steel hardening when dipped in it at the ordinary hardening heat.

NOTES FROM MANCHESTER, ENGLAND.

JAMES VOSE.

Notwithstanding a fairly steady output, the year 1903 has not been characterized by general briskness in the engineering trade of the Manchester district, and the returns of the principal trades unions show an increasing percentage of unemployed amongst their members. Several concerns have, however, been extremely busy. Geo. Richards & Co., Ltd., have double shifts in several departments most of the time. The output during 1903 has been a record one. The pressure of orders is such that important extensions and rearrangements of the shops are under consideration. Boring and turning mills up to 10 feet in diameter have been in great demand, many of them fitted with individual motors—a practice found by Geo. Richards & Co. decidedly on the increase. By means of their patent feed box a large range of positive feeds is instantly obtainable, and their latest improvement is a patent balancing arrangement to the tool bars or slides which entirely dispenses with weights and chains, thus removing what is an objectionable feature in machines as generally built. A recently introduced machine is a duplex turret head boring and turning mill to deal with work up to 24 inches diameter, which has been received with considerable favor, a ready market having been found for the initial machines.

A specialty with this firm is Pearns' pipe facing machine, originally introduced by Mr. Frank Pearns, for facing all descriptions of pipes; but this title is now almost a misnomer, as the machine is so easily adapted to cylinder boring, turning, milling, special facing, etc., that the word "pipe" might well be omitted. A detailed description of this tool might be in order later on. Other lines which have been in good demand are side planers and horizontal boring machines, and the air compressor and sand-blast branches of the firm's business have been continuously engaged on orders throughout the year.

On the other side of Manchester, Bradbury & Co., Ltd., Oldham, are bringing out a turret lathe specially adapted for heavy work. I recently availed myself of an opportunity of seeing it at work, and having its advantages demonstrated, and was very favorably impressed with the solidity and excellent finish of the tool and the ease with which, notwithstanding its massive proportions, it may be manipulated. The hollow spindle has a 4 1-16-inch hole through it, the diameter of the front bearing is 8 inches, and the rear one 5½ inches. A range of 18 speeds in geometrical progression is obtained by friction double and treble back gear in the headstock, and a special countershaft, and by a few quickly-made changes about 60 feeds are available. The tool right through seems a capital blend of the good points of British and American practice. It weighs about 11,000 pounds.

Small turret lathes for the electrical and similar brass-finishing industries have been a strong line with the company for some time, and several important detail improvements were brought to my notice, including a new automatic stock feed motion, dispensing with the objectionable features of the usual wire-feed arrangement.

Mr. S. N. Brayshaw, of Manchester, whose work in the manufacture of milling cutters and analogous fine tools has, during the last few years, attracted considerable attention, has recently made a decided step in advance in the direction of the precisional hardening of cutters, etc., made from carbon steels. As the result of experiments extending over a considerable period, he is now in a position to harden the most intricate cutters, tools, etc., with practically no risk—in fact, the hardening risk has, in his own practice, to all intents and purposes, disappeared. As a result of the fact being made known to the engineering trade he has been almost overwhelmed with hardening orders from outside concerns. In consequence of his researches, he believes he is in a position to prove that in many cases tools may be satisfactorily hardened or ruined within a temperature range of 6 degrees, and can demonstrate a distinct change of appearance in the fracture of a piece with a variation of 1 degree. In the process, which is protected, the articles are partly heated in a gas furnace and then transferred to a special furnace where they are immersed in a bath or melt of salts, the temperature of which can be regulated by means of Bunsen burners and a very delicate electrical pyrometer to within a fraction of 1 degree. After remaining in the melt a length of time varying with its character, the article being dealt with is plunged into water, and the operation is complete. A careful record is kept of every article hardened, and the correct temperature having been found, any number of pieces of the same shape and composition of steel may be hardened with absolute certainty. Mr. Brayshaw prefers hardening customers' own work, but is open to supply furnaces, pyrometers, etc., with the necessary instructions, where such is desired.

Following a prevalent tendency, Meldrum Bros., Ltd., have recently built and equipped a new works on modern lines at Timperley, 7 miles out of Manchester, and are already feeling the benefit of their new facilities for the handling and production of their specialties. Their old shop in Manchester was described in these columns some years ago.

The joint committee of the Manchester Municipal School of Technology and the Manchester Association of Engineers have presented their report on experiments with high-speed tool steels. The report is of an elaborate character. The chief deductions to be drawn from it are, that comparatively moderate speeds and heavy and coarse cuts will remove more metal in a given time than very high speeds and lighter and finer cuts; and that the power required for high-speed cutting does not increase in anything like the same ratio as the speed.

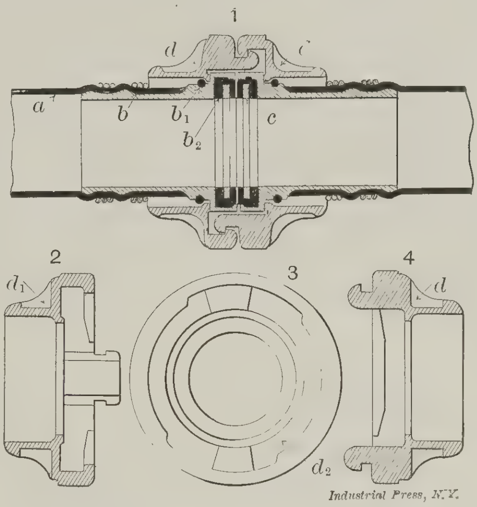
* * *

THE STORZ SYSTEM OF PIPE COUPLINGS.

The Storz coupling, like all others of its kind, consists of three principal parts: The lock, the packing and the cover, the latter being entirely independent of the first two. The coupling is formed in two halves, of which the lock and the fastener are exactly alike. The lock takes holds of a groove with a bayonet motion. Since each half, d and d_1, has two hooks, the coupling is held together at four points, two of which are quite sufficient to maintain a perfectly tight joint, so that the other two merely serve to strengthen the connection and act as a reserve. The locking mechanism turns about the binding ring which holds the packing in place, and yet the lock can be turned for coupling or uncoupling without revolving the packing with it, and furthermore, a worn out piece of packing can be removed and replaced without separating the joint. A strong ring protects the bayonet hooks from injury, both when they are opened and closed.

In coupling, the bayonet hooks first slide in the grooves and then enter a decreasing screw surface, so formed that the coupling cannot open of itself, while a slight backward movement of the coupling serves to tighten the packing. The dimensions of the grooves are such that coupling and uncoupling with the dust and dirt that may accumulate in them has no influence whatever. In addition to this there is so much play allowable between the different parts that even when made upon a large scale there is no trouble at all in securing perfect interchangeability.

The construction of the coupling is shown in the illustration; Fig. 1 being a longitudinal section of the whole, while Figs. 2, 3 and 4 are the details. The packing is self-tightening, both by internal as well as external pressure. The rubber-lipped ring, b_2, is pressed more and more tightly into place the higher the water or air pressure in the pipes. These rings are so set in the ends of the pipe castings that they cannot be forced out by any pressure, no matter how high it may be, and further, even when the coupling is opened, the rings are so arranged that they are still protected by an extra outside ring.



Figs. 1 to 4. Storz Pipe Couplings.

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In the May, 1903, issue mention was made of the magnesium-aluminum alloy known as magnalium, which has a specific gravity of 2 to 2.5, and other valuable characteristics. Carl Zeiss of Jena has developed two light aluminum alloys called zisium and ziskon which, although heavier than magnalium, have special characteristics that make them also of interest. Zisium has a specific gravity of 2.95 and is somewhat ductile. It makes excellent castings of close texture and rigid structure. The metal works well in the lathe and is handled the same as brass, being turned dry. Tests show that it has a tensile strength of about 11,000 pounds per square inch of section, and an elongation of 0.9 to 1.3 per cent. It takes a high polish and is silvery-white in color. Ziskon is stronger, having a tensile strength of about 25,000 pounds with an elongation of 0.7 per cent. It is heavier than zisium, its specific gravity being 3.35, and is less ductile. It also makes fine castings, works well, and takes a high polish. The unfortunate feature of most such alloys is that the best results can only be produced by an expert who makes his mixtures, etc., with all the accuracy required for a chemical analysis. How it is with these we are not informed, but if they are of the practical everyday nature of, say, brass or bronze mixtures, there should be a considerable field for their use outside that of the manufacture of philosophical and experimental apparatus.

* * *

The maximum boiler horse power in central power stations is only attained during a few hours of the day. During the greater part of the day the capacity required is much less than this maximum. On this account it has been found economical and practical to design the boilers and chimneys of ample capacity for this load and to force them above and up to the maximum by means of mechanical draft. This is applied with equal success to old and new plants. In the new power station of the Denver Tramway Power Co., Denver, Colo., mechanical draft is used as an auxiliary to the natural draft provided by a chimney 240 feet high. Artificial draft is furnished by three Sturtevant electrically-driven steel plate fans. The boiler capacity of the plant is approximately 6,000 horse power.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The cost of concrete, of course, varies with the locality, but as a general statement it may be said to average one-half the cost of heavy masonry. For piers and abutments the cost of concrete is about $5 per cubic yard as against $12 per cubic for stone. In the vicinity of New York the cost of concrete is estimated at about $6 per cubic yard.

A novel testimonial has been presented to Mr. William E. Corey, president of the United States Steel Corporation, by his associates in the operating department of the Carnegie Steel Company. It is a silver model of a hydraulic forging press such as is used in the manufacture of armor plate, mounted on a base of classic design, the whole being made of silver having a total weight of 535 ounces.

The Girard College for orphan boys in Philadelphia was founded in 1831 by Stephen Girard, who left a bequest of $2,000,000 for that purpose. The chief building is a somewhat remarkable piece of architecture in a number of features. It is an early example of a building heated by the circulation of hot air from furnaces built in the cellar. Flues for ventilation were built in the interior walls which had their apertures in the apex of the arch in each room.

In relation to the protection of steel from corrosion Mr. Edward Atkinson says it appears that any paint on which reliance can be placed for the protection of steel or other metal from corrosion, must be one which dries by evaporation or sets like hydraulic lime. It must not be one which hardens by the oxidation of the oil or any other ingredient of the compound in which lead or other pigments are mixed. Steel has so great an affinity for oxygen that it is corroded by the oxidation of the oil itself.

In a hill-climbing contest at Eagle Rock, West Orange, N. J., November 26, a 30-horse power Mors racing automobile broke all records by making the distance of one mile uphill in 1 minute 36¾ seconds. Another machine, the Stevens-Duryea, made the same course in 1 minute 37 seconds. Eagle Rock is a famous hill that has been the scene of numerous bicycle and automobile hill-climbing contests. It is about 400 feet high and is approximately one mile in length with an average grade of 8 per cent. The steepest part of the grade, however, is estimated to be fully 15 per cent.

What may prove a valuable discovery, or rather, development of the "singing arc," is reported to have been made by some students of the Missouri University at Columbia, Mo. No details are given beyond that it has been found that if an ordinary telephone transmitter be connected in a certain manner with an electric arc lamp, the latter will reproduce whatever is spoken into the receiver, and with greatly amplified volume. The arc, it appears, acts as a giant receiver, reproducing laughter, cat-calls, college yells, etc., with a power never to be hoped for from the most hardened collegian brazen throat.

Mr. Edward Atkinson, the well-known fire insurance expert of Boston, does not approve, it is said, of the round bottom pails usually provided in mills and factories for subduing small fires. The round bottom, designed to prevent such pails being used for ordinary purposes, also, it appears, makes them very unhandy in case of fire. There really is little reason for not providing the readily obtainable and cheaper flat bottom galvanized pails for fire purpose in the well-ordered shop or factory. It argues for a very slack condition of affairs if such pails cannot be provided without their being used for illegitimate purposes.

Gear cutting is now done so rapidly by those concerns making a specialty of commercial work, especially the steel gears for street railway motors, that the difference in cost of the steel casting and the finished gear is a surprisingly small sum. One well-known gear-cutting concern making a specialty of this work cut the teeth of steel motor gears 20 inches diameter, 5 inches face, 3 diametral pitch at the rate of one tooth in one and one-half minutes. Automatic machines are employed for the purpose so that the labor cost of attendance is divided among a number of machines each having a capacity of from six to seven of the gears per day.

A railway company in Illinois has planned an innovation for the farmers along its line. It has rigged up a portable motor, and whenever any of the farmers want power to run a threshing machine, shredder, wood cutter or other machinery the motor will be set up in the farmyard or barn and connected with a portable wire connection to the lines of the railway. It is claimed that this will afford the farmers a cheap power for grinding and other uses. The railway people will also undertake a lighting plant for the farmhouse and barns.—*Electricity.*

The student engineer when told that the work required to lift a weight is identical whether done in a second or a century, accepts the truth with a lingering feeling of a difference existing somewhere, until he learns that difference to be one of power, or the rate of doing work. Then comes he to know *time* to be a very essence of the world; its root idea, speed—rapidity—dispatch. And so he finds it when coming to the larger activities of life. Time, and the saving of it, the keynote everywhere. Speed—rapidity—dispatch, demanded in mill and office, factory and store. Power thus comes to have a meaning new and wider than the narrow limits of technical definition. Power to do work well, and to do it quickly is the power that controls. Applied alike to men and to machines, it fixes the standard of worth.—*C. H. Morgan, in A. S. M. E. papers.*

One serious trouble with electric incandescent lighting is that, as the lamps grow old, their lighting power diminishes, but so gradually does the change come on that the user seldom notices it, although he may in a vague way be aware that the light is not as satisfactory as it was in the beginning. Some electric lighting companies make periodical renewals of all lamps and thus preserve the prestige of this method of securing excellent illumination; but this, unfortunately, is not the general practice. A lamp-making concern has recently perfected an incandescent lamp that automatically extinguishes itself when its lighting power has diminished about twenty per cent. With the use of these lamps it is expected that more general satisfaction will prevail as it will be impossible to use lamps after they have outlived their period of maximum usefulness.

The time clock to register the comings and goings of employees is one of the modern shop institutions that has grown into general use within the past few years. "Ringing in" and "ringing out" is not a particularly pleasant feature of modern time-keeping to the average American machinist, to be sure, but is a great discourager of that form of time wasting—tardiness. But unless the foremen are promptly on hand, the apparent saving of time may be practically wasted by the men neglecting to commence work with the blowing of the whistle. It is a somewhat delicate task to insist that the foremen shall also register by the time clock, nevertheless it is done in the shop of the King Machine Tool Co., Cincinnati, Ohio, and the application of the rule does not stop with the foremen—the superintendent and even the president of the concern himself observe the rule, so that all are on an equality in this regard.

The matter of successfully and economically removing cylinder oil from the condensation of marine and other condensing engines so that it may be safely used for boiler feeding, seems to have been effected only indifferently in this country—so indifferently in fact that nearly all our stationary plants allow the condensation with practically all its valuable heat units to flow to waste. In English practice one of the most successful devices for this purpose is the Rankine cartridge filter which is made in simple, compound and triple effects. It consists essentially in the simple form of a perforated metal cylinder covered with a double layer of filter cloth. One end of the cartridge is left open so that water filtering through the sides may escape at the end. The cartridge is mounted in a suitable case, so that it may be readily removed and replaced by another with a clean cloth. The compound and triple effect filters work on an extension of the same principle. The water passes through two and three distinct layers of cloth arranged concentrically or otherwise.

The preservative effect of hydraulic cement on iron and steel work has been vaguely understood for many years by a few, and occasionally evidence to that effect is published. We have known of iron tanks being "whitewashed" inside with a thin layer of liquid cement to prevent rust, but for how long it is effective there is no data at hand to inform us. A case where a thick layer of cement was used to preserve thin riveted wrought iron pipe has come to public notice. Some forty-four years ago pipes were laid in New Brunswick, N. J., which were covered inside and outside with pure Rosendale cement about one inch thick. Samples of the pipes recently taken up show the metal to be in an excellent state of preservation. Another rust preventative that is little used, is any good white lead paint, filled with dry sand immediately after application. The writer knows of painted and sanded tin construction that has been used under trying conditions for some years without serious deterioration. A double paint and sand coat it appears would last indefinitely.

Round taper ropes have been used in this country—at the Comstock, where they were in use for about ten years, 1875 to 1884. The ropes, which were made by the J. A. Roebling Co., were two inches at the top and one and three-quarter inches at the bottom. The load at the end of the rope was about ten tons. In Reuleaux's "Constructeur" details are given of a taper rope used in the mines of Przibram, Austria, twenty years ago. The ropes were used to hoist from a vertical depth of 3,900 feet. They were built of crucible steel wire having a breaking strength of 120,000 pounds and were made with a very regular taper from the small end. One wire was cut every sixteen feet and a larger one was brazed on. Consecutively in the process larger ones were joined on until the rope was complete. Each rope was composed of seven strands around a hemp center, each strand being made up of six wires around a hemp core. The initial factor of safety due to static conditions alone, and without considering the effects of bending, was about seven. It is stated that the ropes lasted from three to four years, making 100,000 trips a year.—*Mining Reporter.*

A patent was recently granted to the Halske-Actien-Gesellschaft, Berlin, Germany, for a combination of steam turbine and dynamo, or rather dynamos, which, although somewhat novel, we believe has been proposed before. The idea is to reduce the velocity of the turbine revolving parts (which is of the De Laval type) by mounting the steam nozzles on a tubular shaft so that they may revolve in a direction opposite to that of the turbine wheel proper carrying the buckets. Steam reaches the nozzles through the tubular shaft, and both this shaft and that of the bucket wheel are connected to dynamos running in parallel so that while no mechanical connection exists between the two generators, they must keep in step in accordance with the well-known conditions governing the action of alternating generators running in parallel. Consequently the two revolving elements of the turbine must run at a fixed relative speed, the action and reaction being the moving force of the two generators respectively. The theory as to the turbine efficiency is that the velocity of the revolving parts may be reduced one-half without affecting it since the velocity of the steam issuing from the nozzles is unchanged relative to the buckets. This is true, but the velocity of discharge from the buckets *relative to the casing and the atmosphere* is one-half the peripheral speed of the bucket wheel, whereas, theoretically, it should be zero.

THE EFFECT OF VANADIUM ON STEEL.

L'Echo des Mines et de la Metallurgie.

When from 3 to 5 parts per 1,000 of vanadium are added to steel, it communicates remarkable properties. Properly speaking, vanadium does not bestow on iron or steel any new property, but it doubles the coefficients of resistance to fracture under all circumstances (shock, crushing, elongation, etc.), and at the same time imparts such extreme hardness as to render it possible to reduce almost by half the thickness of the armor for vessels. It is difficult to comprehend that the presence of from 1-3 to ½ per cent. of any element whatever in an iron alloy can have so intense and general an effect, though this effect is perhaps explained by the extreme avidity which under certain circumstances vanadium has for oxygen. This avidity might account for the fact that the presence of even the slightest quantities of vanadium in a bath of steel in fusion would lead to the immediate and absolute reduction of every trace of iron oxide still existing in the mass. Now to these traces of oxide, which are inevitable without vanadium, the rupture of the best prepared steels is attributed. Crystals, even miscroscopic, of oxides would act like the stroke of a diamond on the thickest glass.

A peculiar property of vanadium steels is that they acquire their maximum of hardness, not by tempering, but by annealing at from 1,300 to 1,500 degrees F. This has various consequences. For instance, a lathe having a cutter of vanadium steel may be set at work with greatly increased velocity. Soon the tool becomes heated, and even when it attains red heat, it still continues to take off shavings of iron or castings without exhibiting any dulling effect. It is almost unnecessary to remark that in such a case a cutter of ordinary steel would become completely softened and lose its cutting power. This property is of particular importance for projectiles. It is known that the shock which they experience on striking the target raises them to an elevated temperature. If, by means of vanadium, this temperature does not diminish the hardness of their points, and consequently all their sharpness is preserved, the penetrating force will remain intact. The applications of vanadium steel may be numerous. It is said that they may cause a revolution in armaments. The present price of vanadium in France is about $14 a pound.

SPINNING STEEL SHAPES.

Ryerson's Monthly, January, 1904

Metal spinning is one of the few lines of trade where machinery seems to have little chance of superseding the work now done by thousands of skilled mechanics, work which in complexity of design and excellence of workmanship is truly wonderful. The principle of spinning consists in forcing, by the continuous pressure of a tool of simple shape, a sheet of metal into a revolving pattern, or else raising it by the same method over this same pattern or chuck. In the first case the inner surface of the chuck must correspond to the outer contours of the article to be reproduced, while in the latter the chuck actually forms the pattern. One of the necessities for this work is a good spinning lathe. Almost any lathe with a few changes and attachments may be used, but it is always economical to have a machine properly designed for this particular line of work. The strains on a lathe to be used for spinning are great, calling for a heavily built and well-proportioned machine. The speed at which the lathe is run must depend on the work and the quality of the metal used. A speed of from 15,000 to 22,000 revolutions per minute is about the usual rate.

The chucks or patterns are usually made of hardwood, generally white beech. Metallic chucks cannot be used, as in this case the sheet metal would very quickly spin hard. The chucks must be turned very smooth and be so arranged that they can be secured firmly to the mandrel. Where a small hole in the metal is permissible a steel rod about a quarter of an inch in diameter is used. This peg, as it is called, passes through the metal blank to be spun and also through the chuck, is arranged with a thread at one end and a knob at the other, and holds the metal in place until it can be tooled down to the shape of the chuck. The spinning or tooling down is done with tools of various shapes and designs. They may have faces which are flat, club-shaped or curved, but are always very smooth and the edges are kept dull. The shape of tool best fitted for each kind of work is learned only by experience, it being next to impossible to give definite directions for the many kinds of work which come up. The plate of steel is made to revolve by the mandrel, while the tool is pressed in slow strokes against it until the plate has gradually fitted itself to the pattern. After this has been done a flat tool is used to press out the metal. Care must always be taken that the metal does not wrinkle, and for this purpose, in the first part of the spinning, a flat surface is held under the plate and opposite the tool. After spinning the tension is relieved by hammering with wooden mallets and by annealing.

KRUPP'S IMPROVED SPRING STEEL.

Mechanical Engineer, November 7, 1903, p. 623.

A recent patent granted to Fried. Krupp, of Essen, relates to steel suitable for the construction of springs, and has for its object, by a special composition of the steel, to simultaneously increase its tensile strength, elasticity and toughness, in comparison with other well-known kinds of spring steel, so that a greater working capacity of the spring may be attained without increasing its weight. The first-class Martin and crucible steels hitherto employed for the construction of springs, such as those for railway vehicles, possess a strength when hardened of not much over 79 tons per square inch, with an elastic limit of about 63 tons per square inch.

The necessity has recently arisen for the construction of springs of steel which shall be capable of being subjected to considerably greater demands than the usual Martin and crucible steels hitherto employed for this purpose. To meet this necessity the spring steel, according to Herr Krupp's invention, is produced, containing 0.4 to 1 per cent. of carbon, and a comparatively large amount of silicon, say between 1 and 4 per cent., added to it. The raw material may be quite ordinary Martin steel, to which the required silicon is best added in the form of the cheap ferrosilicon, prior to casting. Experiments have proved that steel of this composition, when hardened, possesses an increased strength of about 14 tons at the elasticity and breaking limits, and may consequently be subjected to greater demands than the usual spring steels. The steel also shows where fractured a fibrous structure resembling wrought iron, a sign of the great toughness of the steel. These advantages are obtained, as will be seen from the preceding description, with quite a trifling increase in the cost of the ordinary steel, so that in the silicon steel a material is obtained which is well suited for the construction of springs.

COMPOUND METALS.

Engineering (London), December 25, 1903.

The successful welding of different metals, whose welding points lie more or less apart, is a problem which has long baffled the efforts of metallurgists; for, except in the case of precious metals, all attempts in that direction have, until recently, proved futile. This has been particularly the case when it has been tried to give iron or steel the appearance and qualities of superior metals, such as copper, bronze, or aluminium. Metals whose welding points lie fairly close together have been made to unite by heat and pressure, as, for instance, iron and copper; but the result was of no practical value, because of the brittle alloy which was formed at the junction of the two metals, and which caused them to separate during subsequent rolling processes. This serious defect appears now to have been overcome by the invention of Mr. Heinrich Wachwitz, a metallurgical engineer of Nuremberg, who has succeeded in joining the most dissimilar metals by means of the application of aluminium between them, and without in any way impairing their natural ductility. Among the most important combinations produced in a commercial sense are, perhaps, the following: Copper-plated steel, aluminium bronze-plated steel, aluminium-plated steel, steel-plated aluminium, copper-plated aluminium, and silver-plated aluminium. Other useful combinations can, however, be produced, including triple combinations for special purposes. Copper can also be united to zinc, and lead to iron. The following are a few of the uses to which sheets made from compound metals have been, or can be, put, on account of their moderate price as compared with sheets made entirely from the more expensive metal used in any combination. Copper or bronze-plated steel for light yet indestructible roofing, in either flat or corrugated sheets, tanks, cylinder tubes, cooking utensils, etc. Aluminium-plated steel for the safe and wholesome canning of food for any length of time. Copper-plated aluminium for superior cooking utensils, and many special purposes where it is important to have a safe soldering surface, as well as the extra lightness over pure copper. Steel-plated aluminium for ship, yacht, and boat building, where rigidity is required combined with lightness. Silver-plated aluminium for table utensils, lamps, etc., the rolled-silver plating being much harder than electro-silver plating. The manufacturers contemplate making both copper-plated and bronze-plated iron wire, the uses for which will, no doubt, be numerous. The invention has already been worked successfully on a large scale for about two years by a German company, while two companies in France are also carrying on the manufacture of these compound metals. In England large works have been erected at Greenock for the purpose of manufacturing sheets rolled from these compound metals.

MACHINE SHOP FLOORS.

From Paper by A. Pringle before Canadian Society of Engineers.

In the matter of flooring it has been found that for ground covering something more rigid and durable than 2 or 3 inch plank laid upon sills, as formerly used, is necessary. Brick and many forms of concrete have been used with varying results, but unless laid with particular care they are very likely to settle, crack and wear into holes, becoming finally very uneven; in addition being objectionable from the operator's point of view in that they were hard and cold to work upon.

Another form of floor quite generally used at present is concrete foundation with nailing strips bedded therein. In some instances the tops of these strips were flush with the concrete, while in other cases the nailing strips in question projected 1½ inch to 2 inches above the concrete, thus forming, when the plank was laid, an air space between the concrete and the plank.

Still another form which the writer has used quite extensively and which he believes compares favorably in first cost, durability, rigidity and general service with any of the forms above mentioned, consists of a 3-inch cinder ground, well tamped to receive a 3-inch tar and cinder foundation, rolled level, over which is then laid hot a vulcanite composition 1 inch in thickness. Into this are bedded 3-inch sound hemlock plank, dressed one side and two edges, the rough side being well tamped into the hot vulcanite so as to give an even and true bearing. Toe nailing assists in laying plank true, but if the composition is properly made the adhesion of the plank to the vulcanite, after a few hours, is such that it is impossible to separate them without damaging the plank. The planking is in turn covered with two ply of tarred felt, cemented at the joints, over which is laid, preferably at right angles or diagonally to the planking, a 1-inch matched hardwood flooring, of narrow widths securely blind nailed.

A floor of this description is so rigid that all but the heaviest of machine tools may be erected upon and secured to it without other foundation. The composition prevents moisture reaching the wood, thus preserving it to a great extent from decay. The top flooring will, of course, wear out, but it can easily be renewed at comparatively small cost, as there remains a good foundation of plank to renew upon.

To the writer's knowledge one such floor has been in service for the past six years in a machine shop—all but four or five of the heaviest machines having no other foundation than the floor above mentioned—and all machines are to-day perfectly rigid and true, and the top flooring is not appreciably worn excepting at some few points where the traffic is heaviest.

For upper floors where brick, terra cotta or concrete steel construction is not used, the 4-inch plank flooring with 1-inch hardwood top covering is probably more generally used than any other. The 2-inch by 4-inch flooring laid on edge, instead of 4-inch plank, also finds some favor. This form of flooring is nailed through the side to the adjoining plank and to the running beams. The joints do not necessarily require to be broken on the beams and, therefore, there is probably less waste in laying a floor of this description than would be in the usual plank floor. In case of an extra heavy floor load or where an extra long span is required, 2 inches by 5 inches and even 2 inches by 6 inches may be used in the same manner. The material in question is usually dressed on four sides, one edge frequently being beaded or chamfered so as to give a neat ceiling effect to the floor below.

The writer has found it good practice to lay two ply of tarred felt, cemented at joints, between the lower and top flooring, for not only does this make it dust and oil proof, but frequently in case of a fire it prevents the water dripping down at many points on the machines below.

A floor of this description has been known to be flooded to a depth of 2 inches with water from the sprinklers, and the only leakage to the floors below was at the walls and columns.

KEEPING AN ENGINEER'S NOTEBOOK.

Mechanical World, December 4, 1904.

The compilation of a notebook is one of the engineer's most interesting and instructive occupations. If the compilation is made in an intelligent and systematic manner there is something to look back upon with genuine satisfaction. A private notebook should be characteristic of the writer, and not merely a collection of information readily accessible from a hundred sources. It should contain exclusive information, or at least information arranged in an exclusive manner, otherwise an engineer might just as well purchase one of the many books and save himself much useless labor. The principal points are the selection of the matter and noting it in a proper manner. With regard to selection, the young engineer should consider carefully the particular branch of engineering in which he is engaged, and his notebook should, for the most part, contain information relating to that branch, and should be written for himself only. He should endeavor to make it his ideal book on engineering, and although he may never realize the ideal he sets before himself, the endeavor cannot fail to be beneficial. As to the matter of noting information, there are two distinct methods of recording data and solving problems—the algebraic and the diagrammatic. Each method requires practice to handle rapidly and intelligently, and it is suggested that at the beginning the compiler should choose the one for which he appears to have most aptitude or inclination, and adhere to it as closely as possible. His book will then have a uniformity of treatment which will prove advantageous. Perhaps the diagrammatic system is the better, but this point need not here be discussed. Another important matter in the compilation of a notebook is to quote the source of the information and the date of entry, because if there is reason to doubt the reliability of the information at a later date, the source can be referred to and more carefully examined. Closely allied to the notebook, but distinct from it, is the scrapbook, into which cuttings from the technical journals and advertisements should be pasted. By arranging these in a systematic manner and keeping each class of machinery separate, an extremely interesting volume may be compiled, which will be, in fact, a practical illustrated book on the particular subject to which it refers. The compilation is a very fascinating occupation, as all those who have practiced it will admit; while of its utility there can be no question.

PYROMETERS: WITH SPECIAL REFERENCE TO THE MORSE HEAT GAGE.

Journal of the Franklin Institute, January, 1904.

The committee appointed by the Franklin Institute to investigate the merits of the heat gage invented by Everett F. Morse, Trumansburg, N. Y., gave in their report an interesting resume of the principles employed by others in the design of pyrometers.

Pyrometry is the term applied to measurement of high temperatures such as cannot be determined by the ordinary thermometer. There have been many methods proposed for the measurement of such elevated temperatures, and a number of quite satisfactory instruments designed. The importance of pyrometric determinations is daily increasing, and the field of usefulness of a good heat gage is an extensive one indeed.

Pyrometers have been made which depend on the method of mixtures, otherwise known as calorimeters, the principle of which is too well known to need description. Some have depended on the expansion of metallic strips or rods, and Messrs. Valy and Schorley employed a fluid alloy of sodium and potassium with mercury in a hard-glass tube by which means a temperature up 1,100 degrees F. could be read, as on an ordinary thermometer.

Carl Barus has given a classification of the principles on which pyrometers have been constructed. This appeared in the "Bulletin of the United States Geological Survey No. 54," 1889:

1. Dilatation of solids—
    (*a*) A single solid.
    (*b*) Two solids acting differentially.
2. Dilatation of liquids—
3. Dilatation of gases—
    (*a*) Expansion measured in volume, manometrically.
    (*b*) Expansion measured in pressures, manometrically.
    (*c*) Expansion measured in volume by displacement.
4. Vapor tension.
5. Dissociation.
6. Fusion.
7. Ebullition.
8. Specific heat.
9. Heat conduction.
10. Heat radiation.
11. Viscosity—
    (*a*) Of solids.
    (*b*) Of liquids.
    (*c*) Of gases.
12. Spectrophotometry and color. Rotary polarization.
13. Acoustics (wave length).
14. Thermo-electrics.
15. Electrical resistance.
16. Magnetic moment.
17. Miscellaneous.

The above classification shows that almost every form of thermal phenomenon has been utilized for pyrometers. Probably the most important in practical application, because of its simplicity, is the method of fusion, viz., by means of various metals which, when brought into a heated atmosphere, or in the vicinity of a heated body, will melt, the melting point being known; thus a temperature which will melt one alloy and not another can be said to lie between the two. This, of course, gives but approximate results inside of a wide range, and hence is limited in its usefulness.

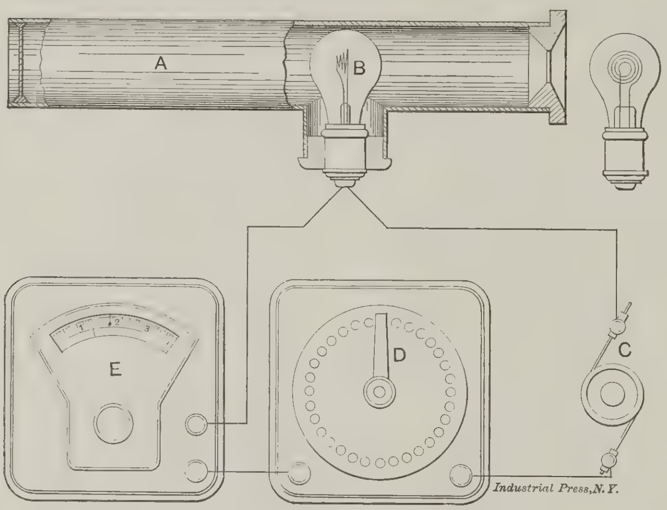
The most important application of this method has been in the determination of temperature of hot blasts in connection with blast-furnace practice.

Quite a satisfactory pyrometer is built on the principle that if a current of water of known temperature be allowed to run through a coiled tube, the temperature of the out-flowing water will be proportionate to the temperature through which it has passed.

An important advance was made with pyrometric construction when Sir Wm. Siemens discovered that an instrument could be made to gage temperatures quite accurately, by comparing the resistance of platinum wire at ordinary temperatures with the same at an elevated degree. The method used is to pass a current through a platinum wire wound about a porcelain tube, balancing the resistance by means of another coil, so that equal currents will pass through both. The platinum wire when placed in the heated medium is increased in resistance—the smaller current traversing it. This current, compared with that passing through the standard coil, is reduced to temperatures recorded on a table. Other instruments have been produced which depend upon the electrical resistance of bodies at elevated temperatures, notably the one of Professor LeChatelier, which consists of a thermo-couple composed of platinum and an alloy of platinum with 10 per cent. rhodium. Such a couple, under the effects of heat, is capable of generating a current which can be measured on a sensitive galvanometer. The galvanometer in practice is standardized for direct reading of temperature. This pyrometer is very extensively used at the present time for some purposes, but it is entirely too delicate a contrivance for every-day use in the foundry.

Other pyrometers have been produced, of which the Morse heat gage is a type, known as "optical pyrometers." In this, the eye of the workman, supplemented by an instrument which enables him to record the intensity of the radiations, becomes a pyrometer, so that the old method of judging temperatures by the appearance of the same is rendered comparatively accurate, and familiar indications of bright redness, etc., are subjected to direct measurements.

The optical pyrometer of LeChatelier is a photometric instrument. In this apparatus the rays emitted from a standard are compared with the rays emitted from a heated body whose temperature is to be determined. A red glass is interposed in the eye-piece and only red rays enter the eye. The photometer depends upon the adjustment to the same brightness of two images, one of the standard and the other of the compared body. The adjustment is made by means of two diaphragms having V-shaped notches opposite one another. They are operated by means of a milled head, and the light admitted depends upon their respective distance from one another. The measurement of this distance compared with the distance apart when observing the standard light is reduced to temperature.



Industrial Press, N.Y.

The Morse Heat Gage and Apparatus.

The methods of optical pyrometry employed previous to the invention of Mr. Morse are unreliable, chiefly because the optical standards for comparison have been placed to one side of the compared, and consequently such comparisons are greatly dependent upon the personal equation of the observer.

The Morse method of gaging the temperature of a material which becomes incandescent when heated, consists in comparing said material, heated to luminous state, with an optical standard so that at least a portion of one is in the path of the rays passing from the other to the eye observing the standard and material, and noting when the one immerges in the other to such a degree as to indicate the correct temperature within the necessary limits.

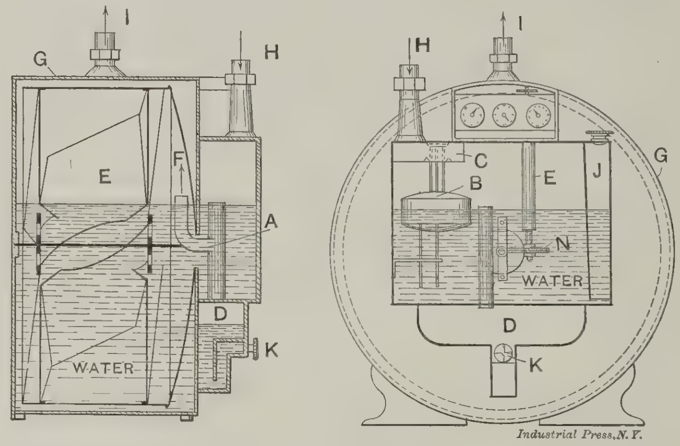
The apparatus consists first of a standard which is preferably a simple incandescent lamp (*B*), the temperature or color of which can be regulated by resistance (*D*) and the amount of current recorded on a milampere meter (*E*). The tube (*A*) containing the standard lamp may or may not be open at both ends, as desired. The tube is held so that the rays passing through the object of comparison will be superposed by the rays of the glowing lamp, the color intensity of which is regulated by the resistance. When the lamp is of the same intensity as the object, the former will be apparently obliterated from the view. At this point an observation of the ammeter and a comparison with the table (the result of calibration with a LeChatelier pyrometer) gives the ampere reading direct in degrees of temperature.

* * *

THE CONSTRUCTION OF WET AND DRY GAS METERS.

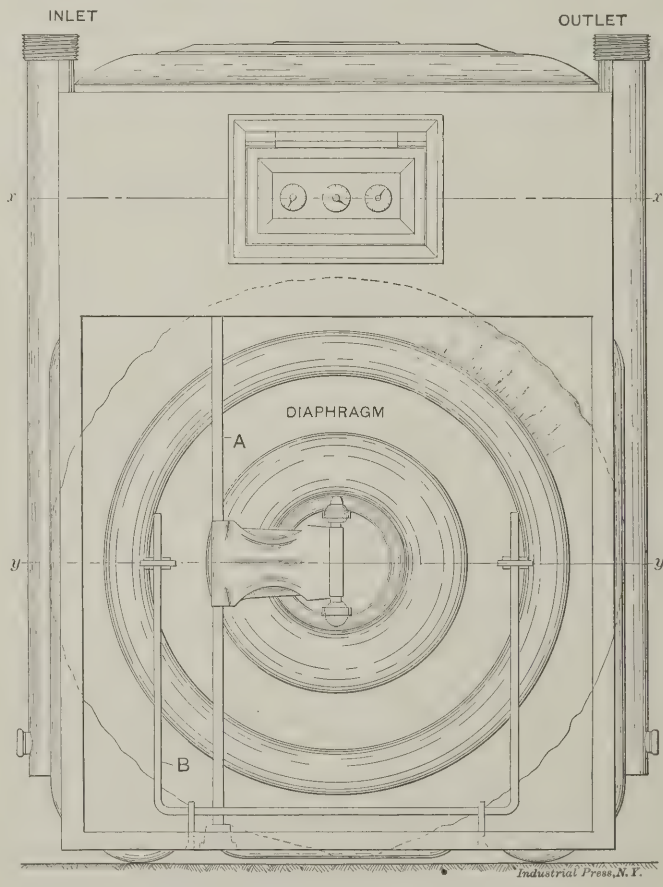
Journal of the Association of Engineering Societies, October, 1903.

One of the first gas meters invented was made of bladders, which were so arranged that one bladder would be filled with gas from the holder, and in expanding would force the gas out from another one already filled, and a valve system would shift the responsibility from one to the other, and thereby furnish a steady supply. This shifting of the valves by suitable clockwork registered the number of times each bladder had filled and emptied. In this way the amount of gas passed could be obtained. These bladders, owing to the properties of gas, soon became dried and cracked, and were finally abandoned for improved devices. The wet and dry meters were the final results of experiments on these lines.



Industrial Press, N.Y.

Fig. 1. Wet Gas Meter.



Industrial Press, N.Y.

Fig. 2. Dry Meter, showing Diaphragms and Leathers

The wet meter consists of a miniature overshot water wheel, *E*, Fig. 1, partially submerged in water and revolving on a shaft. This wheel or drum is divided by partitions into buckets or chambers in such a way as to admit the gas into one of the partitions above the water. The pressure of the gas acting against the partition on one side and the water on the other causes it to revolve, and just before this section begins to shut off from the supply another section comes in and begins to take gas. Immediately after this, the first section shuts off the intake, and, being already filled with gas, begins to discharge the gas into the case which surrounds the drum. Given the exact cubical contents of these various chambers, the quantity of gas passed with one revolution of the drum can be ascertained; and properly constructed gear wheels, operated by a worm and wormwheel N on the main shaft, register the amount of gas that passes.

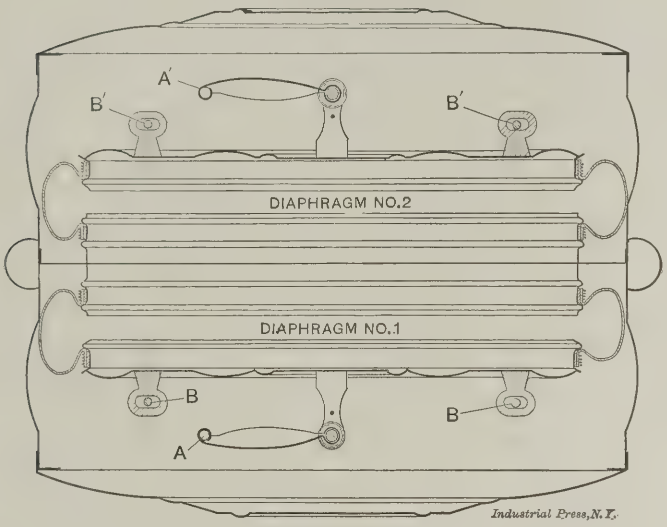


Fig. 3. Horizontal Section through Center of Diaphragms on Plane y-y, Fig. 2.

The dry meter operates through two slide valves, and the working parts of the meter are two or more diaphragms attached to the valves by means of rocking shafts $A\ A'$, Figs. 2, 3, 4 and 5, and link motion. The diaphragms are given freedom of movement by means of leathers attached to the diaphragms and to the partition between them, and the whole is inclosed in a case. As gas is admitted on both sides of the diaphragms, it is evident that movement of either diaphragm causes a flow of gas to the outlet of the meter. When one diaphragm is on the dead center, the other one is in full action, thereby producing a steady flow of gas. The links operate a crank shaft G, and this crank shaft operates the valves $V\ V'$ and the registering gear C through the worm E. The area of the moving diaphragm, multiplied by its lineal travel, will give the cubical displacement, and the consequent flow of gas can be known for a given number of movements of the diaphragms. The diaphragm leathers are soaked in oil, and so long as they remain sound the registration of the meter will continue correct. The chief difficulty, however, is that these leathers in time become hard, and the constant movement of the diaphragm cracks them and a portion of the gas begins to pass through without registering.

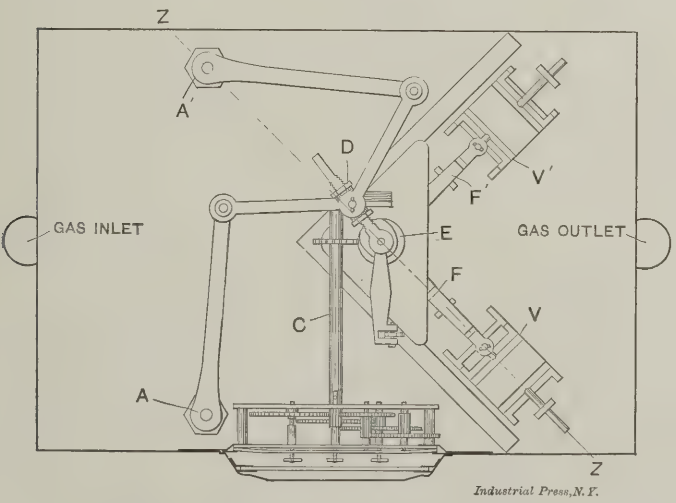


Fig. 4. Plan View of Works, Section x-x, Fig. 2.

Fully 90 per cent. of the dry meters that are wrong are found to be slow. One can readily see from the construction of the meter that in order to make the meter run fast the travel of the diaphragm must be reduced, but the limitations of the crank shaft require a certain amount of motion on the part of the diaphragm to pass the dead center, and if this is not met, the meter will refuse to operate. The adjustment is made by the nut and screw on the crank at D.

* * *

THE VOGT GAS ENGINE.

Engineering (London), January 8, 1904, p. 37.

The author describes a new type of gas engine which in a model of 1¾ horse power promises most remarkable efficiency, this small engine having developed one indicated horse power with a consumption of 16 to 18 feet of town illuminating gas. In addition, it has mechanical features of great apparent value, as will be seen further on. A large engine of 1,000 horse power is to be built to prove the correctness of the design for large sizes—it has been amply proved in the small size in the opinion of the experimenters.

The Vogt engine is of the two-cycle double-acting type, giving in one cylinder two impulses per revolution. It has no water jacket, requires no lubrication and the working parts are at a normal temperature lower than the corresponding parts of a steam engine. This is simply effected by filling the cylinder with water and exploding the charges in vertical chambers above the water. Sections of the engines are shown on the following page, in Figs. 1 and 2.

The cylinder C carries vertical combustion chambers B_1B_2, at its ends. The cylinder is completely, and the combustion chambers partly, filled with water, the height of the water in the chambers depending on the position of the piston as it reciprocates. The gas, air, and exhaust valves are situated at G, A and E, and are all operated in a positive manner by means of eccentrics, rods, and trip-gear, as shown. Both the gas and the air are pumped to the cylinder under pressure, the gas pump being driven off the crankshaft by a crank-pin set in advance of the main crank, and the air-pump being directly attached to the extended piston-rod R of the motor cylinder. Intermediate receivers may be used for both gas and air supplies. An ordinary water service under about 10 pounds pressure is utilized to inject a little fresh water at each stroke, as required for cooling purposes, and below each vertical chamber are water valves K, communicating to spring-loaded valves L, which are so operated and adjusted as to retain more water in the chamber when the quantity of the explosive mixture is diminished, and so regulate the clearance as to give a constant compression pressure for all charges.

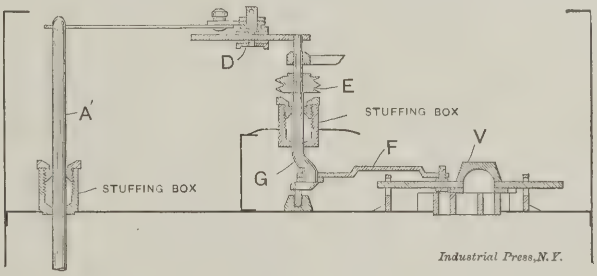
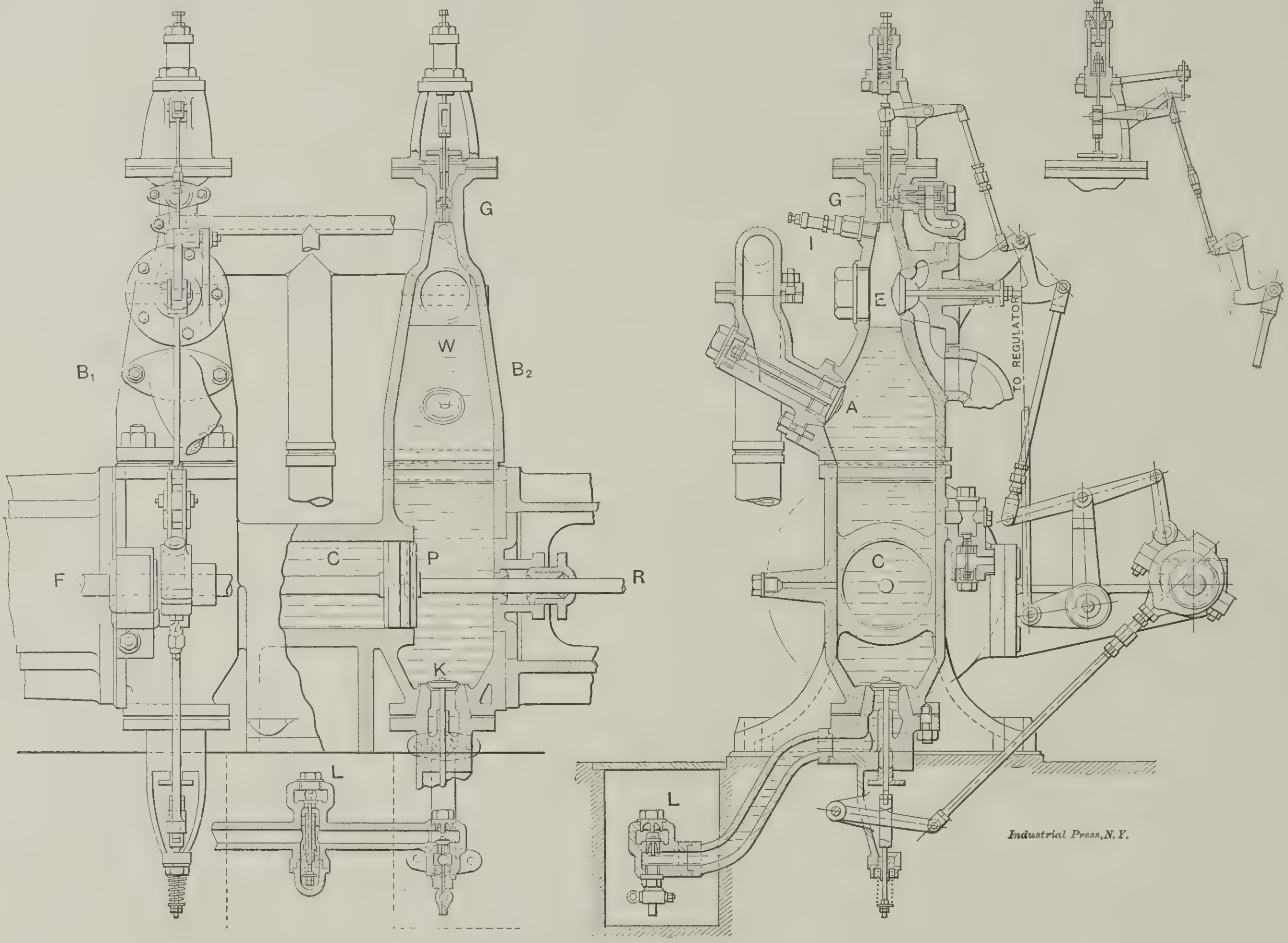


Fig. 5. Section through Flag and Crankshaft, Plane Z-Z, Fig. 4.

Starting with the piston in the position shown in Fig. 1, and with a charge of gas and air compressed in the chamber B_2—*i. e.*, in the space at the top above the water surface W—the action of the engine is as follows: Ignition is effected by the electrical igniter I, Fig. 2, explosion takes place and pressure upon the water surface at W drives down the water column, and forces the piston to move toward B_1, the work being transmitted through a crosshead and connecting-rod to the crankshaft in the usual way. Toward the end of the stroke the exhaust valve is opened and the pressure drops to atmosphere. The water level is then below the air-inlet valve, and this valve now opens, admitting air under slight pressure and in excess of the total combustion chamber volume, so that all the burned products are swept out and the cylinder left full of fresh air. If the engine happens to be on full load, the exhaust valve closes soon after the in-stroke has commenced; at the same time gas is supplied under sufficient pressure to force it into the cylinder, and then both gas and air are compressed together. The amount of water expelled through the valve *K* during compression is in this case a maximum, and the final clearance is that necessary to give the desired compression pressure, which pressure is constant (being equal to that at which the spring-loaded valve lifts), and independent of the quantity of mixture or its temperature. On the other hand, if the engine is on light load, the exhaust valve closes later and the gas valve opens later, the first portion of the in-stroke serving only to expel some of the air previously drawn in. At a given point, determined by the governor, compression begins, and even with a light charge the same compression pressure is reached, but more water is retained in the chamber, so as to reduce the clearance to the proper capacity.



Industrial Press, N.Y.

Figs. 1 and 2. Longitudinal and Cross-section of Vogt Gas Engine Cylinder.

From the operations described above it is obvious that a movement of the governor as the load decreases has the following results:

(a) Closing of exhaust delayed.
(b) Inlet of gas delayed and gas valve throttled.
(c) Amount of water escaping at valve *K* reduced.

Some of the advantages claimed for this engine are the following:

1. Same number of impulses per revolution as the steam engine.

2. Piston and stuffing-boxes under water, reducing wear and friction.

3. Air and exhaust valves always well cooled since they are under water once each stroke.

4. No unequal expansion between the piston and cylinder.

5. No water jacket required. Simple castings as thick as desired may be used.

6. Valve gear and eccentrics similar to those used on steam engines. All valves positive acting.

7. Quality of mixture and high compression remain constant.

8. With badly cleaned furnace or producer gas the dirt or dust has no injurious effect.

9. High efficiency.

* * *

VENTILATION OF THEATERS BY FORCED CIRCULATION OF AIR.

The ventilation and heating of a theater presents a problem not easily mastered by the ordinary heating engineer. In a crowded auditorium of this kind ventilation is the all important question. It may be a simple matter to heat the building to a required temperature before the curtain rises, but to maintain a constant temperature and a pure atmosphere while the play progresses is not so easily accomplished. The heat given off from the bodies of the closely seated audience is sufficient to raise the temperature in the house from 5 degrees to 10 degrees during the performance. Fresh air to breathe must be supplied constantly to the occupants and the impure air must be removed. Evidently a system giving a forced circulation of air is necessary to meet these requirements. A good example of this system is the recent installation in the new Franklin Square Theater at Worcester, Mass. The heating and ventilating apparatus consists of an electrically-driven fan and heating coils, located in a corner of the basement. Fresh air is drawn from the outside and circulated through coils of steam pipes inclosed in a fire-proof casing and distributed through ducts by means of the fan to the desired parts of the theater. There are plenum chambers under the orchestra floor and first balcony from which air is admitted through openings in the chair legs, giving an even distribution throughout the house. The low velocity with which the air enters prevents annoyance from draughts. The foul air is exhausted through grills in the dome of the theater and by means of an electric exhaust fan is discharged through the roof. The B. F. Sturtevant Co., of Boston, Mass., were the heating and ventilating engineers, and the apparatus installed is of the Sturtevant manufacture.

ALLOYS OF HIGH TENSILE STRENGTH.*

HERBERT E. FIELD.

The composition 55 per cent. of copper, 42.5 per cent. of zinc and .5 per cent. of tin, which is used under various names, makes a very strong bronze when properly mixed. The strength given by Prof. Thurston is, however, too high for the mixture when it is used in practical work. Prof. Thurston's results, if I remember correctly, were obtained in laboratory experiments; very small amounts of the metal were melted and in this way the temperatures and mixtures were very accurately regulated and to an extent not possible in commercial practice. The test bars made by Prof. Thurston were, I believe, cast in small iron molds, which greatly increases the strength of some bronzes—if not of all, as will be explained later in the discussion. The above mixture is given by Prof. Thurston as combining a maximum strength with a maximum elongation. It is very close to the composition specified by the government for the tray castings which form a part of the breech block mechanism of the steel coast-defense mortars. They originally took this mixture from Thurston and their specifications based on his results originally called for a higher strength than it was practical to obtain in foundry work. It was consequently reduced. This mixture will readily serve as a good basis to work on or to approach to. Even when all new metal is used it is difficult to get the exact composition desired in the resulting casting. This is principally due to the rapid oxidation of the zinc which forms a considerable proportion of the mixture. If this oxidation was constant it would be possible to allow for it, but as the oxidation increases as the temperature increases the temperature would have to be kept constant each time the mixture was used, which is not possible in general foundry practice. Again, if scrap is used from the preceding heats a further error creeps in, due to the loss of zinc in the first mixture. If any considerable amount of scrap is used the error will gradually increase until the mixture will, when analyzed, show a decrease in zinc and an increase in the copper and tin.

I have used mixtures with tin up to 1 per cent. and still obtained good results. I would not recommend this, however, if a high elongation is desired. 57 per cent. of copper, 42 per cent. of zinc, and 1 per cent. of tin makes a strong mixture, but the elongation varies greatly, frequently falling below 10 per cent.

The chief difficulty with these mixtures lies in their tendency to form an open crystalline metal which is not homogeneous. When properly mixed and cast, the metal has a uniform close crystalline, or fine grain, structure which appears to be necessary in order to produce a metal of high strength and high elongation. I do not think that the causes of this peculiar appearance have been clearly explained. It most frequently occurs in large masses. A small runner or test bar will frequently have a fine uniform fracture and give a tensile strength 20 per cent. higher than will a specimen turned from a large mass cast from the same ladle. The latter may have the open irregular fracture above referred to. A test bar 1 inch in area and cast in a chill would give a higher strength than the same sized bar cast in sand, which partly accounts for the high results obtained by Prof. Thurston. These two instances indicate that the rate of cooling has a great deal to do with the strength of bronze of this composition. If this difference between large and small sections was always noticed we might say that the mixture was not suited for heavy work. This is not the case, however, and I have seen many large sections with a perfect fracture, with high strength and high elongation.

There are four factors which enter in to make a successful bronze of this composition. First, the composition; second, the purity; third, the temperature to which it is heated; and fourth, the method of mixing.

Composition.—We have already noted that the composition must be kept within fairly uniform limits but that an increase of ½ of 1 per cent. of tin does not affect the strength, but does frequently reduce the elongation.

Purity.—It is absolutely necessary that pure metals be used in making this mixture. The ordinary commercial products contain so much impurity as to make it impossible to obtain a satisfactory bronze of this composition. The metal which causes the most trouble in this respect is zinc. Most of the cheap commercial zincs contain a large percentage of lead. A very small percentage of lead will greatly reduce the strength of this bronze and it is absolutely necessary that the lead be kept down to a trace, if good and uniform results are desired. There are zincs on the market which are practically free from lead. These bring an increased price, but the extra cost is more than repaid by the greater proportion of castings obtained of the required strength. There is a considerable variation in the copper. Just what causes this has not been determined. It is certain, however, that a copper having a relatively high electrical conductivity will give a high tensile strength when used in this mixture. Whether this decrease in strength caused by some brands of copper is due to sulphur, arsenic or some such impurity, I am unable to state. It is, however, a simple matter to have a specimen taken from each lot of copper and tested for conductivity. If this conductivity is high, you can be fairly sure that your trouble does not come from the copper. The tin used is such a small percentage that it is not liable to contain a sufficient amount of impurity to do any harm. It should, however, be free from lead.

Temperature of Heating.—When a bronze is defective in any respect we always hear a great deal about oxidation. We know that oxidation weakens such metal and we also know that the higher a metal is heated, the greater is the tendency to oxidize. It is difficult to determine that this is the exact cause of the variation in this metal; we do know, however, that this bronze must not be overheated. The duller it is cast and still be sound and free from blow-holes, the stronger will the metal be. The decrease in strength, owing to high heating, may be due to three causes. First, crystallization; second, segregation; and third, oxidation. We have noted in the early part of the discussion that weak specimens frequently showed an open crystalline fracture. We also know that the slower a metal cools, the larger will be the crystals. The higher we heat the bronze, the longer will it take to cool, and hence the greater will be the tendency to crystallize. A great deal of attention is now being paid to segregation in studying alloys. By segregation we mean the tendency of one metal to separate out or come together in one part of an alloy. The peculiar irregular appearance which the alloy frequently assumes is attributed by some to the segregation of the tin. I have seen specimens of this bronze in which a sufficient amount of tin has collected in one spot to make it possible to get a sample which showed upon analysis that it contained several times as much tin as did the surrounding bronze. It is a difficult matter to determine whether the very small particles which appear to destroy the homogeneous structure of this bronze is due to this cause or not. The fact that the tin does occasionally segregate in sufficient amounts to be analyzed would indicate that there was some ground for assuming that this was the case. We know that slow cooling is necessary to segregation. We have noted that the higher the bronze is heated, the slower will it be in cooling and consequently the greater will be the opportunity for the tin to segregate. This forms one more argument in favor of casting the metal at as low a temperature as possible. We find that a small percentage of aluminum added to this mixture frequently improves it and adds to its strength. The aluminum is supposed to act as a deoxidizing agent and the improvement in strength may be due to the fact that the metal has been deoxidized by the aluminum. A very small piece of metallic phosphorus added to the metal improves it, provided it is not added in sufficient quantities to leave any of the phosphorus in the bronze. It is a difficult matter to know just how much to add. An excess is worse than none at all. Aluminum, however, is preferable, as it is easier to add and a slight excess does not seem to harm the metal.

Method of Mixing.—The one point to be kept in mind in melting and mixing this alloy is not to overheat it. There are two methods which give satisfactory results. If all new metal is to be used the copper should be melted first; when it is melted, it should be cooled down as much as possible before the zinc and tin are added. The mixture must be well stirred with a carbon stick and when at the correct temperature for pouring, the aluminum should be added, and the mixture stirred and poured at once. If scrap from the previous heats is available, the copper may be melted first and the scrap added to reduce the temperature before the zinc and tin are added, or the scrap may be melted and the copper added as soon as it is melted. The zinc should be added while the metal is still at a comparatively low temperature. The former is the safer method, as the scrap serves to decrease the temperature of the copper before the zinc is added. The second is the quicker way, as the bath of melted scrap hastens the melting of the copper. The disadvantage lies in keeping the bath of melted scrap with its high percentage of zinc in the melted condition for a longer time, and hence giving more time for it to oxidize.

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* Written in answer to a correspondent who has had trouble in securing a strong composition by using Dr. R. H. Thurston's well-known formula of 55 per cent. copper, 42.5 per cent. zinc and .5 per cent. tin. According to Thurston this should have a tensile strength of 68,000 pounds per square inch.—EDITOR.

In conclusion I would say that it is not possible to obtain 68,000 pounds to the square inch with any regularity; 50,000 pounds is as high as can be expected of specimens cast from this mixture. In order to obtain this, great care must be taken with the details mentioned above. The most important of these are: First, to us pure material; second, not to overheat the metal; and third, to add aluminum if necessary.

* * *

MOTOR DRIVES FOR HARTNESS FLAT-TURRET LATHE.

The illustration, Fig. 1, shows a Jones & Lamson lathe equipped with a Crocker-Wheeler motor operating on the multiple voltage system. The motor has a capacity of 5 horse power at 1,100 revolutions per minute and 240 volts and is mounted directly over the spindle, which it drives by means of a Renold silent chain. Beneath the spindle is placed the regular back-gear, and, when required for large diameter work, a triple back-gear is placed below the regular one. The gears are thrown in or out of operation by friction clutches so that it is not necessary to stop running while making the change. From the motor to the sprocket on the spindle there is a 3 to 1 speed reduction; the first back-gear reduces again by a ratio of 4 to 1 and the second gives 16 to 1 from sprocket to spindle. The motor being supplied with current on the 4-wire multiple voltage system, of the Crocker-Wheeler Company, is capable of six speeds by the separate voltages and six more by the use of one resistance, or twelve in all in either direction. The highest speed is 1,100, which transmitted direct to the spindle turns the latter at about 370 revolutions per minute. The motor's slowest speed, 162 turns per minute, communicated through triple back-gear, makes the slowest speed of the spindle 3 1-3 revolutions. Between these limits there is a total of 36 different speeds in direct or reverse rotation.

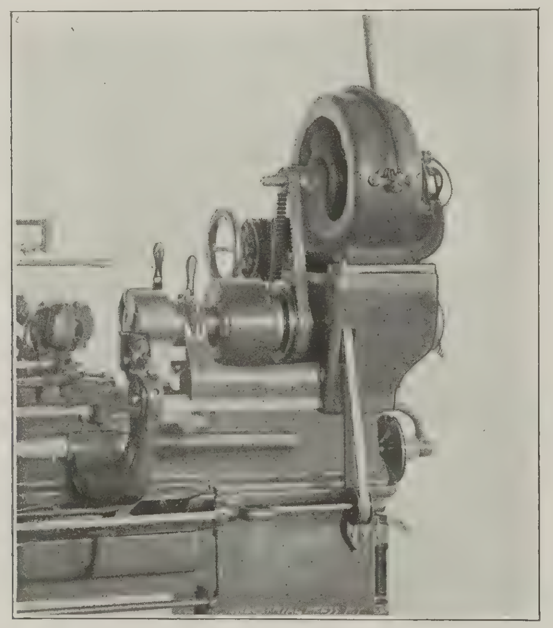


Fig. 1. Jones & Lamson Lathe Driven by Crocker-Wheeler Motor.

Lathe Driven by Northern Electrical Motor.

Another motor attachment for the Jones & Lamson lathe is shown in Fig. 2. The motor was supplied by the Northern Electrical Manufacturing Company, Madison, Wis. It is of the shunt reversible type, for 220-volt current, and designed to run at from 600 to 1,200 revolutions per minute. A Cutler-Hammer drum type controller is used.

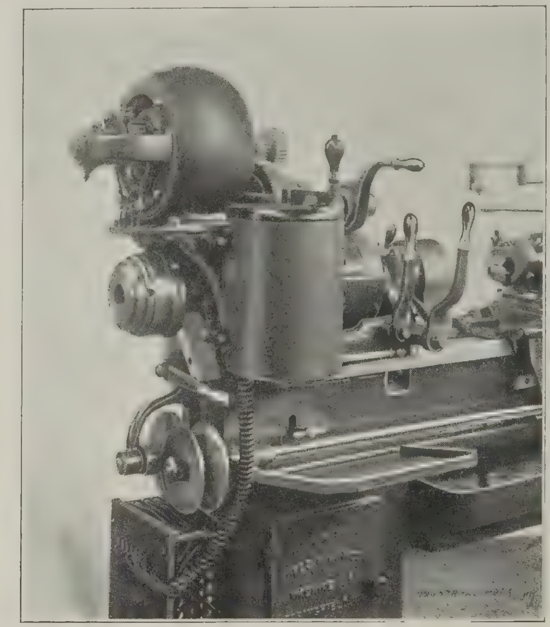


Fig. 2. Jones & Lamson Lathe Driven by Northern Electrical Motor.

In Fig. 3 is a diagram showing the clutch and gear connections between the motor shaft and the lathe spindle. Power is transmitted through the shaft *E* and quill *C*, on which the intermediate gears *A*, *A* and *D*, and the cone clutches *B*, *B*, are located. The quill and shaft turn together, but the shaft slides in the quill and by this means operates the taper cones *B*, *B*, which cause the power to be taken from the motor shaft by one or the other of the two gears *A*, *A*, according to which cone is in contact with its gear. Pins *P*, *P*, lock the cones positively to the shaft *E*, but longitudinal slots in the quill, through which the pins extend, allow the sliding motion of the shaft and pins, necessary to operate the clutches. Power is finally transmitted to the lathe spindle through gear *D*. The spindle thus has two mechanical speed changes, besides the changes due to the controller, and the back gears of the lathe.

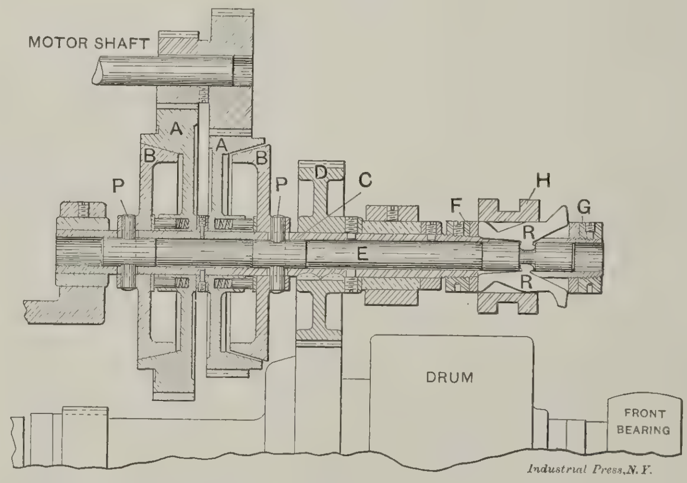


Fig. 3.

The endwise movement of shaft *E* is obtained through the sliding collar *H* and the two cam rockers *R*, *R*. These rockers are held in place in slots in a collar surrounding the quill previously referred to, and both the collar and rockers are prevented from having an endwise motion by the collars *F* and *G*, which are threaded to the quill. The rockers are pivoted in an annular groove in shaft *E*, and the movement of collar *H* in one direction first tilts the rockers, moving shaft *E*, and then further movement of the collar locks the rockers in one extreme position. Movement of the collar in the opposite direction tilts the rockers the other way, moving the shaft in the opposite direction, and finally locks the rockers in the other extreme position. The spring pins shown in the hubs of the clutches are employed to assist in the release of the cones from their seats in gears *A*, *A*.

* * *

ITEMS OF MECHANICAL INTEREST.

GAS SOLDERING IRON—VARIABLE-THROW PUMP FOR LATHE—THE FETTE COTTER DRILL AND SCREW TAP.

At the recent meeting of milling machine manufacturers held at Buffalo, action was taken on the question of standardizing the length of feeds on milling machines. The tendency of the past toward increasing range beyond the legitimate requirements of the market, in order to meet competition or gain a temporary selling advantage, was deprecated and a maximum limit for length of feeds on equivalent sizes of machines was unanimously adopted.

The largest guillotine shear ever built by the Hilles & Jones Co. was recently installed in the warehouse of Joseph T. Ryerson & Son, Chicago. The upper blade is 13 feet 2 inches long and will shear a plate 1½ inches thick and 12 feet long, working between the housings. The overhang or gap is 36 inches, which feature permits a strip 36 inches wide or less to be sheared from the side of a plate of any length, the plate, of course, being moved along parallel with the blade after each stroke. The shear complete weighs 220,000 pounds. It is driven by a 50 horse power Westinghouse three-phase motor, direct connected by gearing and a friction clutch. The frame stands 21 feet above the floor and the total width is 22 feet.

A method for making a brown print from a blue print is given by W. Allen Bartels in *Engineering News*. His directions are as follows: Make a solution of 9 fluid ounces of water and 1 fluid ounce of strong ammonia. Saturate the blue print with this solution until the blue fades away, leaving white paper, then, after rinsing, apply with a sponge or by immersion the following solution:

Water	12½ oz. (fluid)
Tannic acid	2 drachms = 120 grains

The print will then become a dark brown in about 10 or 15 minutes. This has been found a very satisfactory method of getting brown prints with ordinary blue print paper, where the results pay for the labor involved.

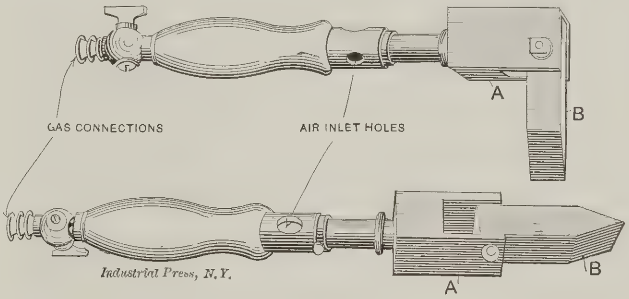
The use of electromagnets in iron and steel works for handling heavy ingots, boiler plates, billets, etc., is one of the applications of the electric current with which we have been familiarized during the past few years. But undoubtedly the humbler electromagnetic cloth pressing outfit for tailors' use is an electric apparatus very few have heard of so far. We are assured by the *Western Electrician* that a Chicago concern, mindful of the hard work imposed on the presser, has brought out such a device which is said to be quite effective for the purpose designed. It consists of two iron bars 24 inches long, 5 inches wide and 1 inch thick, set on edge and placed side by side about 4 inches apart. These bars are connected near their ends by iron cores bearing the magnet coils. When these are energized the edges of the bars become the poles of a powerful magnet. The pressing board is laid on the bars and the tailor's goose acts as an armature, being attracted downward with a force of several hundred pounds. A thumb switch on the goose enables the presser to apply and release the pressure as required.

GAS SOLDERING IRON.

The United States consul at Chemnitz, Germany, describes an alleged novelty recently placed upon the Berlin market in the shape of an adjustable gas soldering iron. The copper bit is movable and can be adjusted at any angle. The consul states that by virtue of this construction the new (?) iron is of great convenience in soldering metallic edges so located as to be difficult of access. The heat generated by the gas flame (Bunsen burner) is utilized to its fullest extent in that the hollow part, *A*, prevents rapid radiation and concentrates the heat upon the copper bit, *B*. This system of heating develops a sufficiently high temperature to permit of the employment of a comparatively small piece of copper in the bit and also economizes in the amount of gas consumed. It is reported that a soldering iron of this kind which does the work of an ordinary soldering iron possessing a copper bit weighing 1¾ pounds consumes but 3.6 cubic feet of gas per hour, which, according to the prevailing price of gas in Berlin, represents a cost of from 3 to 5 cents per ten hours.

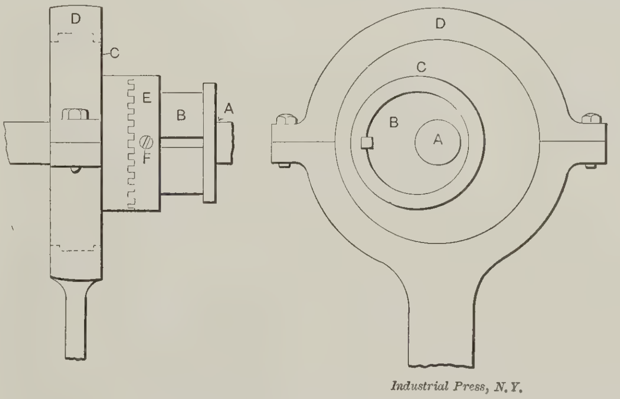
VARIABLE-THROW PUMP FOR DRILLING LATHE.

The Bradford Machine Tool Co., Cincinnati, O., have a somewhat interesting adjunct to a lathe used in their shop for boring lathe spindles, in the shape of an oil-pump having a variable-throw eccentric by which the stroke of the piston may be changed to suit the size of drill and length. That is, the stroke may be adjusted to suit each size of drill or length of hole so that in each case a prescribed flow of oil shall be positively forced to the point of the drill to lubricate it and to clear out the chips. It is obvious that the resistance to the flow of oil is greater with a long drill working in a deep hole than it is with a short drill of the same diameter working in a shallow hole. Again the tubes let into the side of the drill to convey the oil to the point should vary somewhat with the size of the drill, in order to provide a greater volume of oil as the drills increase in diameter.



An Adjustable Gas Soldering Iron.

The accompanying sketch shows the construction of the eccentric. It is really a compound eccentric consisting of two eccentrics, *B* and *C*, one inside of the other. Say that both have the same throw, then when the extreme throw of one is opposite that of the other, as indicated in the sketch, the motion communicated to the piston is zero. On the other hand, when *C* is shifted 180 degrees relatively to *B*, the motion communicated to the piston is double the throw of each eccentric. Say that the throw of *B* and *C* is, in each case, 1 inch, then with the eccentric centers on the same side of the shaft and in the same radial line, the motion communicated to the piston is 2 inches. Intermediate positions would give a stroke varying from 2 inches to zero. The eccentric, *B*, which is keyed to shaft, *A*, is elongated with a boss of the



Variable-throw Pump Eccentric.

same diameter extending to the right. The eccentric *C* surrounds *B* and has a boss extending to the right, which is milled across the end for square clutch teeth. The sleeve, *E*, has corresponding teeth and has a keyway sliding upon the feather set in *B*. When the clutch teeth are engaged the two eccentrics are locked together and give a movement depending upon their relative position. By loosening the set-screw, *F*, the sleeve, *E*, may be disengaged and any required adjustment made. The sleeve and boss are marked, one with a datum line and the other with the sizes of the drills. Now if a 1¾-inch drill is to be used the operator sets the eccentrics so that the datum line is opposite 1¾. Of course the different settings have all been determined by experiment. Change gears are also provided so that the speed of the pump may be varied for cases not covered by the adjustment just described.

THE FETTE COTTER DRILL AND SCREW TAP.

Our attention has been called to samples of the Fette cotter-drill by Messrs. Prescott and Bryant, who own the United States rights for it and the Fette screw tap. Both these tools are the invention of a German, Mr. Heinrich W. A. Fette, Altona-Ottensen, Germany, and were patented in the United States about two years ago. The Fette cotter-drills are being quite extensively used abroad, especially in Germany where such firms as the Gasmotorenfabrik, Deutz; F. Krupp, Essen; General Electric Co., Berlin; Actien-Gesellschaft, Weser, Bremen, and others have taken it up.

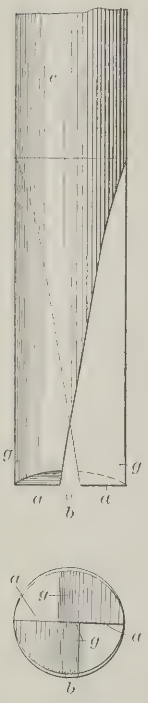


Fig. 1.

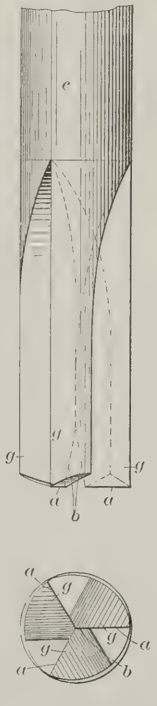


Fig. 2.

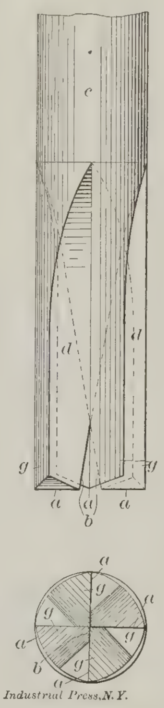


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Fig. 3.

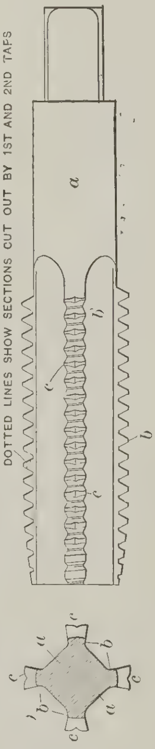


Fig. 4.

At first glance the Fette cotter-drill shown with two, three and four cutting lips in Figs. 1, 2 and 3, seems not essentially different from similar tools used in American practice for key-seating, but on closer inspection of its construction we do not recall having ever seen one working on the same principle. This tool clears away the central teat as it feeds downward independently of any side motion and for this reason can be used as a drill, either for starting its own cut or for other purposes. Fig. 1 shows the tool in its simplest form. It is divided into the longitudinal arms *g* by the grooves *d*, which are cut so that one face of each is parallel with the axis and constitutes the cutting edges *a*. The other side is cut at an angle so that the grooves gradually widen toward the point. This widening of the grooves is such that at the base the core is entirely removed, leaving a triangular space with inner cutting edges, *b*. The ends of *g* are backed off in the usual manner; also the periphery, so as to cut sideways, thus making both a side-cutting and an end mill. When the tool is made with two cutting faces, the grooves are approximately 90 degrees; with three faces, 60 degrees; and with four faces, 45 degrees. When made with more teeth only two of the flutes are carried to the center so as to form the triangular space *b*, the others being made shallow and of the usual form for side-cutting mills. We are informed that these have been made up to 3 inches diameter and that cutters of this size are successfully used by Krupp.

The Fette screw tap requires little description, the cut, Fig. 4, showing the principle quite clearly. It is made in sets of three for hand taps, but they differ from those used in American practice in that the first tap cuts out the base of the thread only; the second tap takes out still more, making a section of the thread a still higher truncated cone section; and the third tap finishes the thread. They are made with four grooves with four rows of teeth as narrow as possible in order to afford a slight elasticity (?). Each set of teeth has a groove, *c*, extending the full length so that each tooth is backed off in both directions toward the groove *c* and as both faces of a tooth are of the same diameter and are sharp, the tap cuts as freely when turned backward as when being screwed into a hole. In this way it is claimed that the breaking of teeth is lessened and the tap made to cut more freely. Further information may be obtained from J. L. Prescott & Co., Paterson, N. J.

DREDGING OPERATIONS BY THE U. S. GOVERNMENT.

An indication of the large amount of river and harbor improvement work now under way or contemplated by the United States Government is given by the fact that at present ten suction dredges are being built, two of which will be sent to the Great Lakes, two to New York harbor, two to the Mississippi River, two to Charleston, S. C., one to Galveston, and one to Savannah, Ga. Five of these are being constructed by the Maryland Steel Co.; two by the James Reilly Repair & Supply Co.; and one each by the W. R. Trigg Co., the Petersburg Iron Works Co. and the New York Ship Building Co.

The mechanical equipment of the dredges for salt-water service will include surface condenser outfits, with Blake air pumps, feed pumps, fire pumps, etc. The dredges for the Great Lakes are provided with very large Blake cross-compound, double-acting air pumps and jet condensers, with the usual complement of Blake vertical duplex feed pumps, fire pumps, etc. The air pumps are of a very novel arrangement, inasmuch as it is possible by the manipulation of valves and cocks provided for the purpose to cut each pump in half and run one side entirely independent of the other side. This practically provides a spare pump in each installation without the necessity of being overweighted with two duplicate machines, and at the same time secures the advantages of compound steam cylinders.

These dredges are the largest in capacity ever built, and are designed in each case for the special work which they will have to do. They are self-propelling, sea-going dredges, and do not depend upon the assistance of tugboats or other craft to move them around from point to point. Some of these vessels are fitted with immense bins, in which the dredged material is deposited, and when full the vessel propels herself out to deep water, dumps the sand or mud and steams back to repeat the operation. Others are arranged for depositing the dredged material into large scows fastened alongside the vessel.

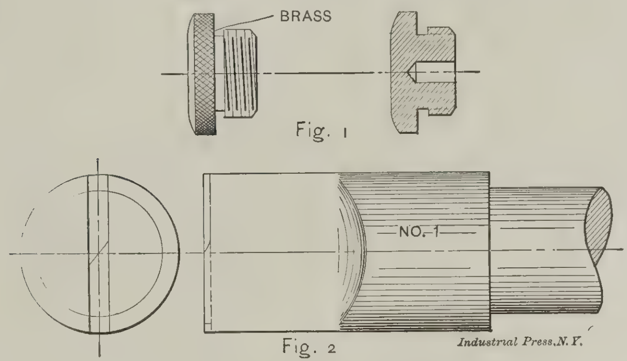
The operation of these machines is very interesting. A long flexible tube 12 to 15 inches in diameter drops down from the side of the vessel 20 to 30 feet or more to the bottom of the river or harbor upon which the dredging operation is being performed. The upper end of this tube is connected to an immense rotative centrifugal pump revolving at several hundred revolutions per minute and capable of handling many hundreds of tons of water per hour. The lower end of the tube is manipulated from the vessel against the sand bars and mud banks, and as the water is sucked upwards by the centrifugal pumps a very large proportion of sand and mud goes with it. The centrifugal pumps discharge this water with its suspended material into the tanks on board the vessel or into the scows, where the heavy matter quickly settles to the bottom, the water flowing back into the sea.

LETTERS UPON PRACTICAL SUBJECTS.

AUTOMATIC LATHE TOOLS FOR MAKING A BRASS OIL BOTTLE STOPPER.

Editor MACHINERY:

The accompanying cuts show some English automatic lathe tools for making a brass oil bottle stopper, having a hole drilled in the center for a spoon made of wire. Fig. 1 shows the stopper—a simple piece. Figs. 2, 3 and 4 show the tools.



Figs. 1 and 2. Brass Stopper and Facing Tool.

The facing tool, Fig. 2, the drill, Fig. 4, and the threading die are used in the main turret; and the forming and cutting-off tools are fixed on the small turret, Fig. 3. This turret is mounted on the cross-slide.

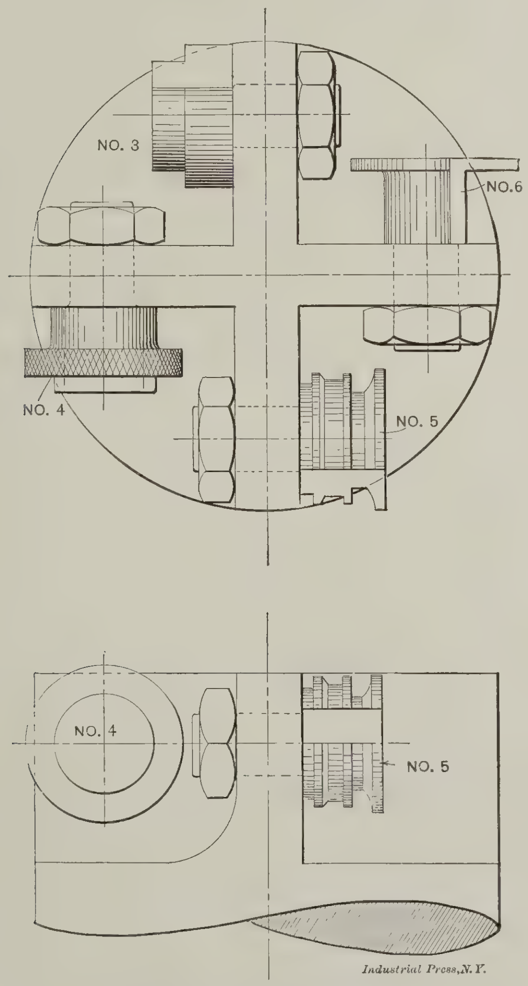


Fig. 3. Turret for Holding the Forming and Cutting-off Tools.

The order in which the tools work is as follows: First operation, No. 1 tool; second operation, No. 3 tool; third operation, Nos. 2 and 4 tools; fourth operation, No. 5 tool; fifth operation, threading; sixth operation, No. 6 tool.

The rate of manufacture of the stoppers with this outfit is about 70 pieces per hour. CHARGE HAND.

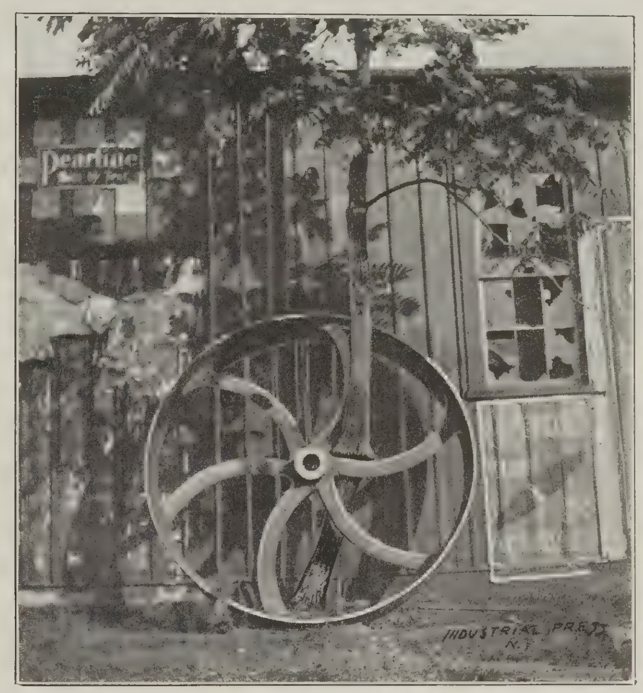
ANCHORED.

Editor MACHINERY:

I send you herewith a photograph that may interest you and your readers. The pulley is 8 feet diameter and 12 inches face. The tree is 12 inches diameter at the butt and is probably forty years old, or more. How the old pulley has escaped the junk man so long is a mystery. J. F. WILLEY.

Jeffersonville, Ind.

[We might say that it is also a mystery why cast-iron scrap of this character is allowed to accumulate around many shops, were it not that it seems to be a common characteristic of too many shop owners to vaguely anticipate some future use for such material. If this pulley, which probably weighs about 1,000 pounds, had been sold forty years ago at one-half cent a pound, the compound interest at 5 per cent. alone would have amounted to over $35, to say nothing, in that event, of its not spoiling what probably would have been a shapely tree!—EDITOR.]



An Old Timer.

RE DEEP HOLE DRILLING.

Editor MACHINERY:

In the January, 1904, number of MACHINERY, we notice an article by Frank B. Kleinhans, entitled "Deep Drilling." We respectfully call your attention to the fact that the writer of the article gives no credit for the design of the special drill described and makes no reference to the shop where used. This he should by all means have done, especially since he is acquainted with the long series of experiments attending the development of the tool. This drill was developed in the shops of the well-known lathe builder, the Lodge & Shipley Machine Tool Co., of Cincinnati, O., and is the outgrowth of the wide, practical experience of their superintendent, Mr. N. D. Chard.

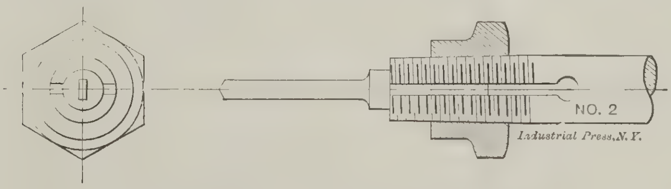


Fig. 4. Drill for Drilling Hole in Brass Stopper.

Further, steps are being taken for the proper protection of the design by letters patent, and the Three Rivers Tool Co. have arranged with the Lodge & Shipley Mch. Tool Co. for the exclusive right to manufacture and sell this drill. We are giving to the tool the name of "The Get-There Spindle Drill." Before long we shall be on the market with this and other "Get There" specialties in the small tool line.

Three Rivers Tool Co.,
per J. G. Matthews.

AN EXPANSION BUSHING ARBOR.

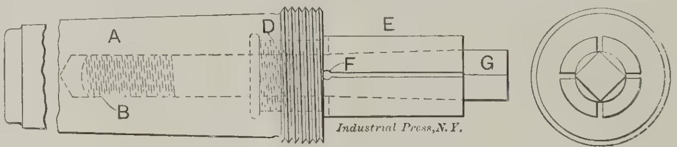
Editor Machinery:

Having a lot of bevel gears to cut on the milling machine, the fact that all were bored to different sizes seemed to require a special arbor for each size of gear, but we were able to save most of this expense by designing and using the expansion bushing arbor that is shown in the accompanying sketch. The shank of this arbor, *A*, was fitted to the dividing head and bored with ½-inch hole, at the bottom of which was a threaded portion *B*. The front end was also bored out and a fine thread cut at *D* for receiving the various sizes of expansion bushings, one of which is shown at *E*. These bushings were bored tapering and four slots were cut from the end to the holes at *F*.

After a gear is placed upon this bushing, the screw *G* is tightened and the bushing thereby expanded, so that it holds the blank firmly in place. This arbor may be used for any number of different sizes of holes, the only requisite being to make a bushing to fit each size. This bushing is screwed in and out of the end of the arbor by means of a spanner wrench. An external thread is cut on the front end of the shank so that a nut can be used for easily withdrawing the arbor from the dividing head.

Albert Elmiger.

Dayton, Ky.



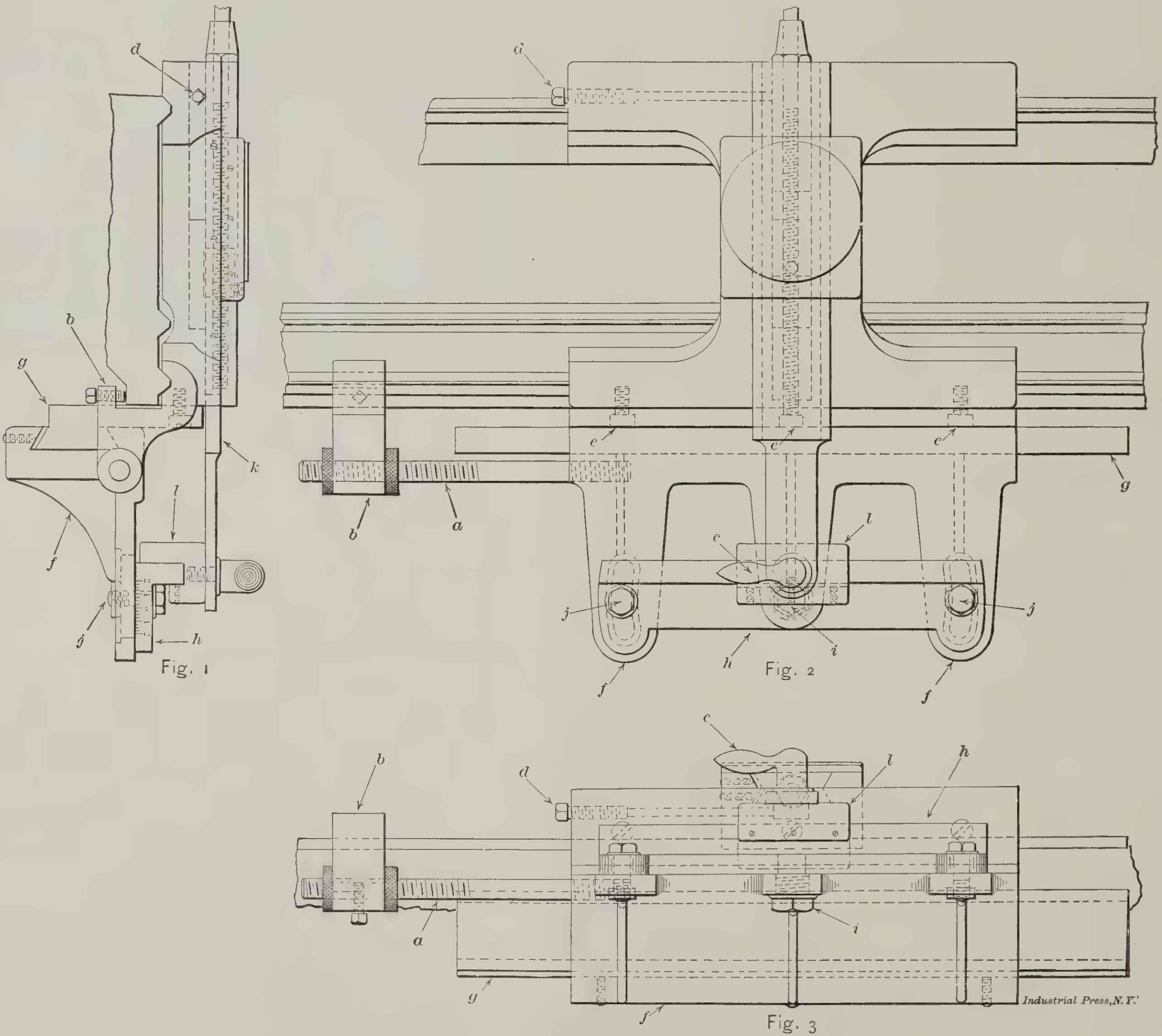
Arbor with Expansion Bushings.

A LATHE TAPER ATTACHMENT.

Editor Machinery:

Upon receiving a very large order one day for all kinds of tapers to be turned and bored in the lathe, and having no taper attachment to any of the lathes, it was suggested to build one rather than turn the order away. This was at first thought to be a rather expensive undertaking, but it was decided to try, and after it had been built and put in use, the outlay of time and money was never regretted. I believe a description of its construction may be of good use to some of your worthy readers (for what helps one may help others), and after coming before the public it may yet be further improved. It has so far proved very satisfactory for all of the work wherever it has been tested.

The assembled drawing of the attachment is shown in three views, Figs. 1, 2 and 3. It is fastened directly to the carriage in the rear, therefore is always in position and ready for use. It travels the entire length with the carriage, as will be seen at the left of the top or plan view, Fig. 2. The connection with the bed is through the screw *a* and the clamp *b*. It is only necessary to tighten the clamp *b* and loosen the screw *d* to turn the work tapered, and *vice versa*, to turn it straight. In either case the binding handle *c* or the screw *d* is not removed.



Figs. 1, 2 and 3. Details of a Taper Attachment for the Lathe.

The attachment is fastened with three screws *e e e* in the rear of the carriage, and projects down so as to be in alignment with the cross-slide. The table *f* slides on the hanger *g* and is provided with a jib to take up whatever wear that may occur. To the table is fastened the arm *h* which turns on the bolt *i*. When the proper taper is obtained, it is held securely in position with two screws *j j*. On this arm slides the piece *l* which is also provided with a gib, and this piece receives the handle *c*, which binds the cross-slide *k*. The top of the carriage is planed across to receive the double-acting slide *k*, and this is provided with a clamping device by means of which it can be fastened at any desired position along the cross-slide. At the bottom of this slide is left a hub about 6 inches long, and 1½ inch wide, to act as a solid wall for the screw *d* which binds it.

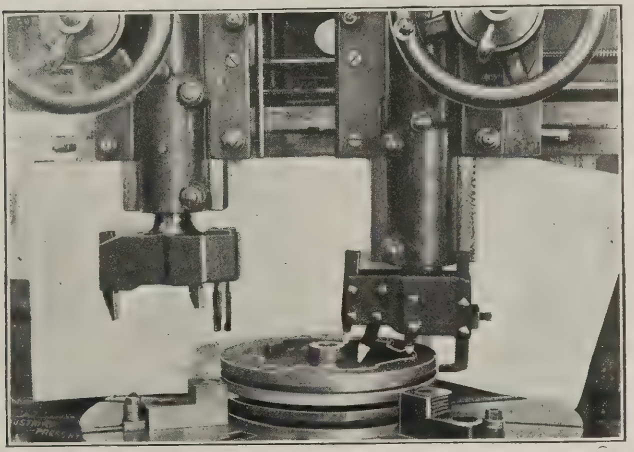
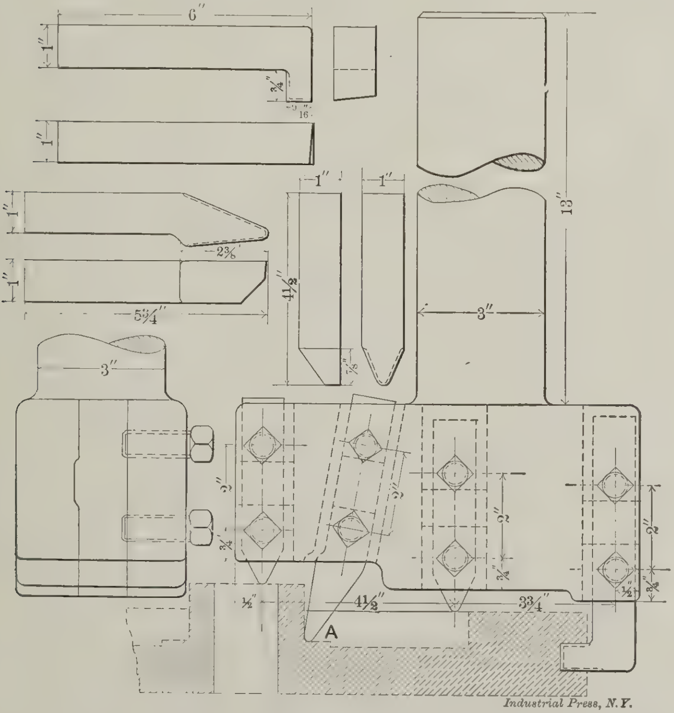


Fig. 1. Tools in Position for Facing, and Turning Packing Groove.

The tool slide is interchangeable with a compound rest, and can be moved independently of the taper slide, and will thus not interfere with the lathe for ordinary purposes. The old-style attachment cannot be moved in connection with the carriage. But as this device makes it possible to move both simultaneously by simply loosening the clamp and thus using it on any part of the lathe, the problem which has so long troubled lathe manufacturers is solved. The simplicity in construction, its wide range of adjustability and the ease with which it can be manipulated, are characteristics which should commend it to the public wherever a lathe is used.



Industrial Press, N.Y.

Fig. 2. Details of Tool shown in Fig. 1.

A. L. Monrad.

New Haven, Conn.

[Perhaps some of the lathe builders will not agree with Mr. Monrad, but may insist that they have already solved the problem on substantially the same lines as outlined above, so far as the general action is concerned.—Editor.]

SPECIAL TOOLS FOR THE UPRIGHT BORING MILL.

Editor Machinery:

The upright boring mill is usually considered to be indispensable in most manufacturing plants, but, being rather expensive in the matter of first cost, every shop manager naturally desires to obtain a maximum production from it, so that the balance sheet at the end of the year will show a profit from its use. Whenever this tool is used for machining parts in considerable quantities it is generally good practice to design a few tools or jigs with the object of producing the parts in the shortest possible time. In most cases such tools pay for themselves by the time saved in finishing the first lot.

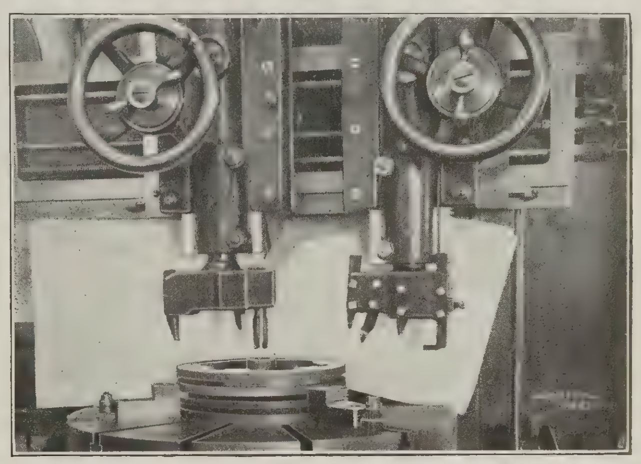
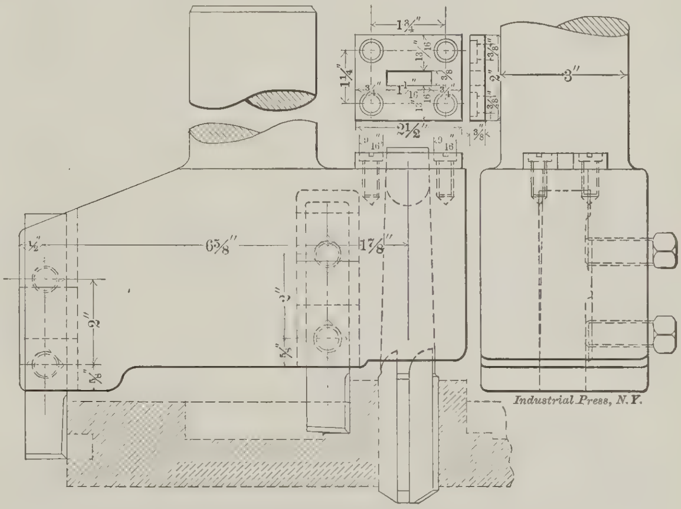
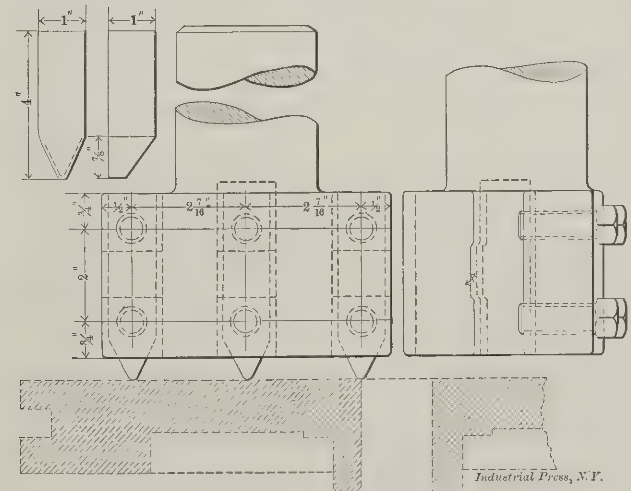


Fig. 3. Showing Tools in Position for Reaming Hole, and Turning.



Industrial Press, N.Y.

Fig. 4. Details of Tools shown in Fig. 3.



Industrial Press, N.Y.

Fig. 5. Multiple Tool for Facing.

Along this line the writer submits the cuts and photographs on previous page, illustrating a set of tools which have proved very profitable for finishing the casting that is shown in the photograph on the table of the boring mill. Fig. 1 shows the tools in the first position in which four operations are performed at one time, and while not completing them in one-fourth of the time of the old method (as it was necessary to regulate the cutting speed by the tool turning the largest diameter), the saving was nevertheless much more than 50 per cent. The details of this tool are shown in Fig. 2, in which the work being machined is indicated by dotted lines. The tools are made of Mushet steel, and each is held in place in the head by two ⅝-inch setscrews. This set of tools operates in a horizontal direction, from right to left, and the different tools in their order, face the end of the hub, face the shoulder *A* at the base of the hub, face the top side of the rim and cut the groove around the outside.

In the other tool post is placed another head which carries the tools that are shown in position in Fig. 3, and in detail in Fig. 4. In addition to the two turning tools this head carries an end mill for boring the center hole in the casting.

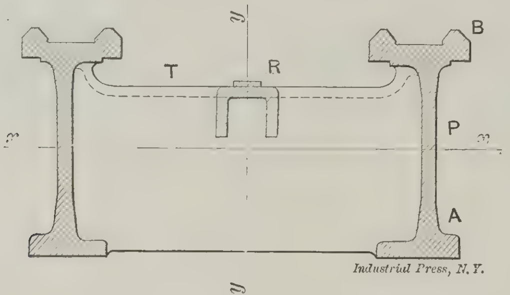


Fig. 1. Cross-section of Lathe Bed.

The operation of these tools is in a vertical direction, the sliding head being set so that the reamer is central with the center of the casting, and then fed downward so that while the hole is being bored by the reamer, the other two tools are turning the outside of the hub and the outside diameter of the piece, thus completing the work on this side of it.

The other side is faced with the multiple tool shown in Fig. 5 which performs the work in one-third of the time formerly required to do it with a single tool. These holders are all simple in construction, of cast iron, being cored for the tools and having their shanks turned to fit the sliding heads of the boring mill.

E. E. Wood.

CHATTERING OF LATHES.

Editor Machinery:

All lathes chatter more or less under a heavy cut. The magnitude of the chatter depends largely upon the weights, design and construction of the machine. In these days, when deep cuts and rapid feeds are required, we find tools which chatter almost unbearably, especially on large diameters.

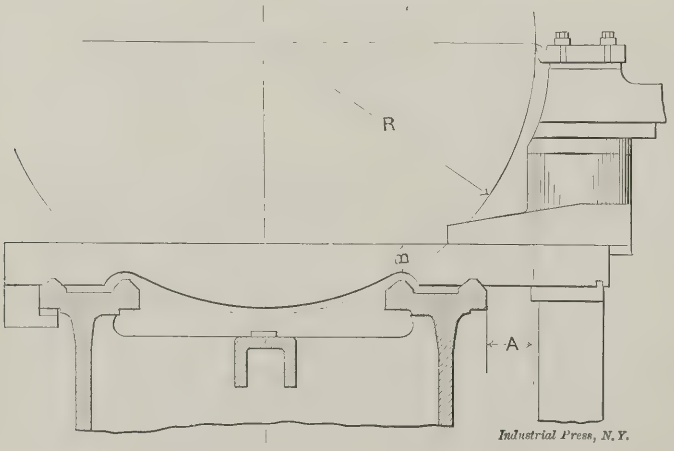


Fig. 2. Overhang of Carriage a Cause of Chattering.

If we wish to take an exceedingly heavy cut, we are, of course, obliged to use a heavy lathe, and this means a lathe with a large swing; for, although the smaller size lathes would swing the work, they do not have sufficient power to handle the heavy cuts. Thus, while a 24-inch lathe would swing a heavy forging 18 inches in diameter, we are obliged to use a 48 or 60-inch lathe for this class of work. Even with lathes of this size, we frequently find that the tool will chatter so much that we are unable to take a cut of sufficient width and depth to stall the machine. In order to prevent chattering we must have a solid bed of great torsional strength. This means that the material should be placed as far from the neutral axis as possible. Thus, in Fig. 1 the portions at *A* and *B* are made heavy, while the plate *P*, which runs the full length of the bed is comparatively thin. The further we keep the metal from the neutral axes *x x* and *y y*, the stiffer the bed will become. The best arrangement for the cross ties *T* is a box section which is open at the bottom. A rack *R* should be cast on another box section and should extend the full length of that part of the bed traversed by the tailstock.

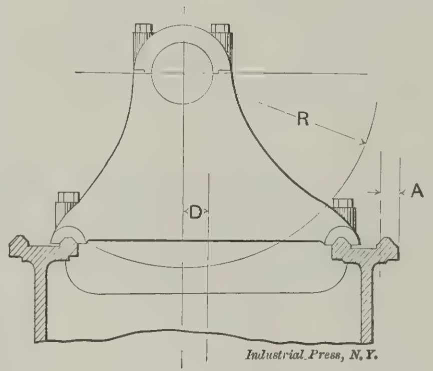


Fig. 3. Center Line of Lathe set over to avoid Carriage Overhang.

Fig. 2 shows a common arrangement of a great many lathes. *R* is the radius of the faceplate. A vertical line dropped from the outside of this faceplate falls a considerable distance, *A*, outside of the line of the bed. On large diameters, therefore, the overhang of the carriage is so much that this portion bends down and we are always sure to have chattering under such conditions. Also on some machines the thickness *B* is made short in order to swing as large a diameter as possible over the carriage. This part being thin, the carriage bends at this point, which action increases the chatter. It is well, therefore, to either make the carriage thicker at *B* or else cut off the V from that side of the bed and build down the carriage to meet it.

If the lathe spindle is thrown back out of the center line of the bed, we can reduce the overhang of the carriage on large diameters. Thus in Fig. 3 we have an end view of a lathe with the center thrown back the distance shown at *D*. A line dropped from the outer end of the radius *R* of the faceplate, falls inside of the line of the bed as shown at *A*. We thus have the downward thrust of the tool on the bed, instead of on the overhang.

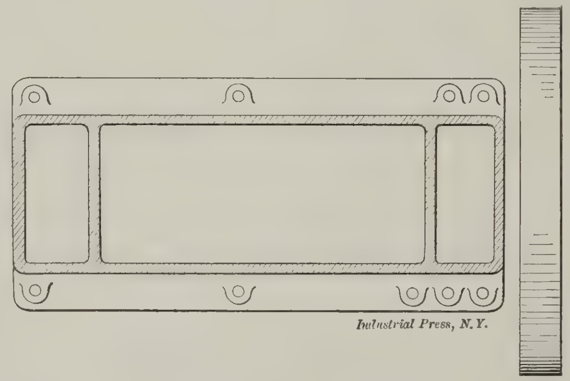


Fig. 4. Headstock Bolting Detail.

Another reason for chattering will be found in the connection between the cap and the headstock and between the headstock and bed. These bolts are almost invariably too light and too few in number. Let us take a lathe with a faceplate pull of 10,000 pounds at its periphery. When we are cutting on a small diameter we are likely to get a thrust on the tool of four times this amount. This, of course, must be resisted by the bolts. If this pull is figured out on many lathes, the bolts will be found to be weak in this particular.

Fig. 4 shows the arrangement of the bolts on a 60-inch lathe of recent design. The bolts were designed so that the fiber stress was not allowed to run above 9,000 pounds per square inch of section. As the pull is on the front of the center, more bolts were placed on this side, and as the lift is at the faceplate, the bolts were placed near the end, as shown. The bolts in the cap should be figured out in a similar manner, for strength. Every bolt stretches under a load, and the longer the bolt the greater will be the stretch. The bolt should therefore be made as short as possible, both for the cap and for the head.

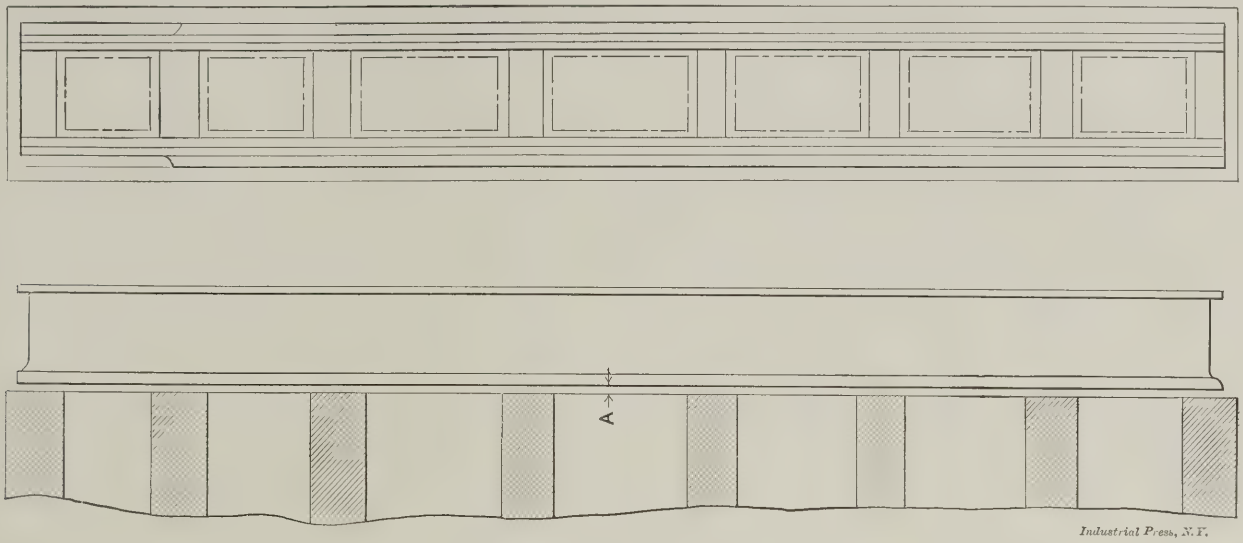


Fig. 5. Lathe Bed and Foundation.

It should be remembered that when driving a spindle through a back gear there is more or less torsion between the spindle gear and the faceplate. If it is desired to use a lathe for heavy work, therefore, a back-geared lathe should not be used, as it is next to impossible to prevent chattering with such an arrangement of gears. Instead, the lathe should be fitted up with triple gears and be driven from the faceplate, preferably through an internal gear, as this arrangement of gearing gives a smooth, positive movement, with very little chance for torsion.

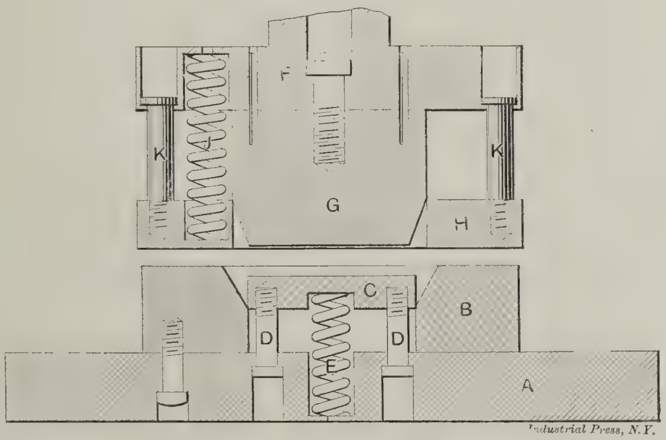
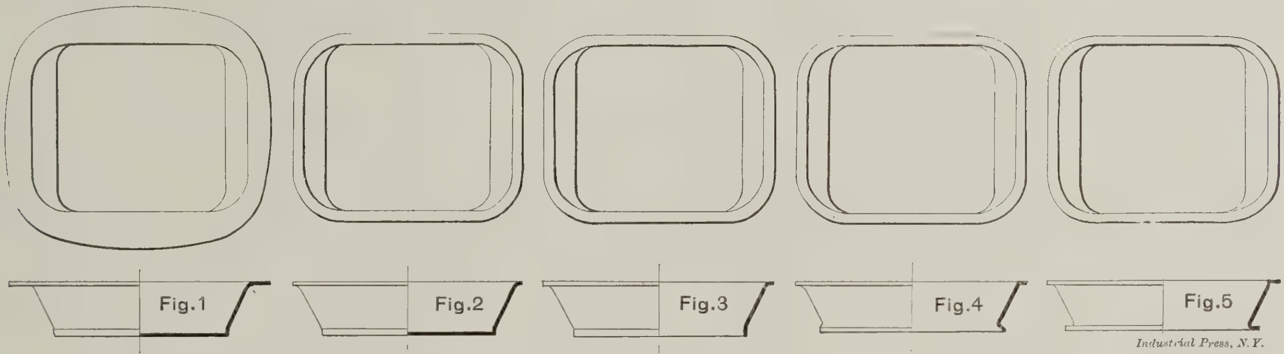


Fig. 6. Punch and Die for Drawing the Blank.

No matter how well a lathe may be designed for heavy work, if it is not properly bolted down to a firm foundation it is almost certain to give trouble. Fig. 5 shows a large lathe bed and foundation. A distance *A* of about one inch is allowed for sulphur or cement. The foundation bolts are conveniently arranged on the inside of the bed and located near the corners. Clamps are then placed across the corners to receive these bolts. After the sulphur or cement has hardened, these bolts should be drawn up tight. There is little chance to spring a bed that is thus properly bolted down on its foundation. If these precautions in the design and in the setting up of a lathe are taken, we are sure to have a machine which will run smooth under the heaviest cuts and be practically free from chatter. Frank B. Kleinhans.

Royersford, Pa.



Figs. 1 to 5. Showing the Progressive Operations in the Making of Shunt Spools.

TOOLS FOR MAKING SHUNT SPOOLS.

Editor Machinery:

A short time ago we had occasion to produce a number of shunt spools for use in electrical work and the tools by which these were made are illustrated in the accompanying sketches. Figs. 1 to 5 show the progressive operations by which these pieces were made, Fig. 5 being the completed spool. The material used was soft sheet brass .025 inch in thickness. In this particular instance no attempt was made to develop a perfect blank for drawing, or to make a blanking die for cutting the pieces out, as we had in stock a lot of round blanks of the required thickness which were waste material from

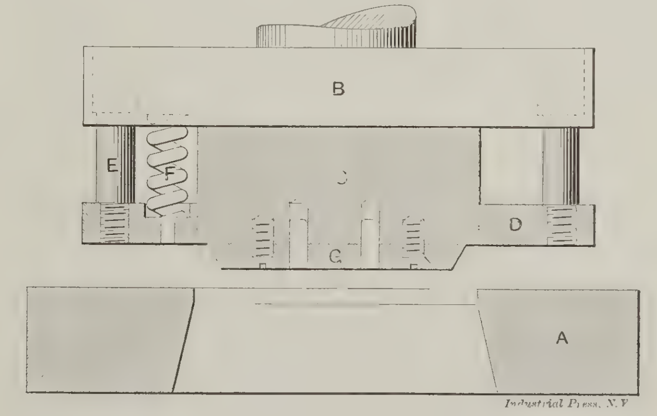


Fig. 7. Punch and Die for Trimming the Blank.

other stampings and proved to be very well suited to our purpose. The tools will be described and illustrated in the order in which they were used.

Fig. 6 shows the punch and die that were used for drawing the blank to the form shown in Fig. 1. The tool steel die *B* was fastened to the cast-iron holder *A* by screws and dowel pins, and the ejector was secured in place and limited in its upward movement by the screws *D*. Beneath the ejector were placed the four springs *E*, which forced it and the blank up and out on the return stroke of the press. To locate the blank in position on the face of the die four pins were driven in the die and a corresponding number of clearance holes were drilled in the blank holder of the punch for them to enter. In the punch, *F* is the holder and *G* the punch proper, while *H* is the blank holder and is made of machine steel and polished on its face. Eight helical springs, *J*, made of 1/8-inch steel wire, were employed to hold the blank and prevent any wrinkling, while the blank holder was held evenly in position by the four screws *K*. This arrangement worked very well, although under ordinary circumstances a rubber cylinder is preferable for holding down the blank holder instead of the springs, but they were used in this case for want of material to do otherwise.

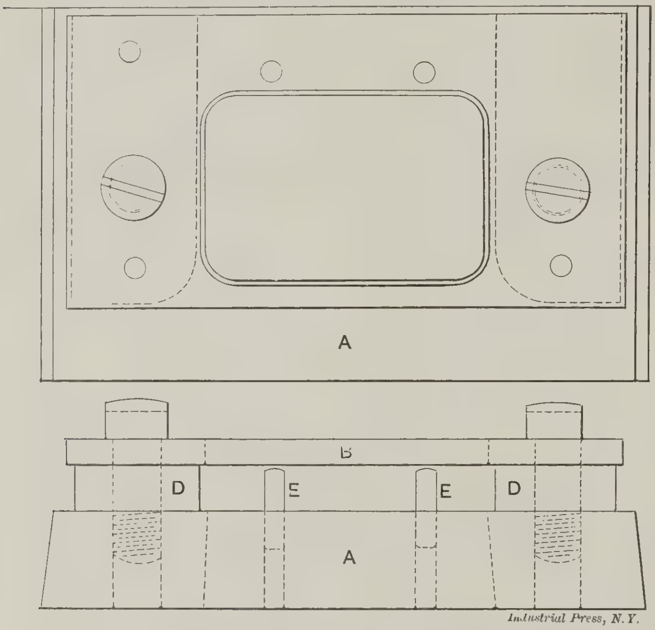


Fig. 8. Plan and Side of Die used for Cutting out Bottom.

After the drawing operation the blanks were trimmed by the punch and die shown in Fig. 7. *A* was a plain blanking die with the hole finished straight for about 1/8 inch, while for the remainder of the distance an extra amount of clearance was given to allow the work to drop through as each piece was trimmed. The punch consisted of the holder *B*, the cutting punch *C*, and the stripper *D*, which was held in place by the four screws *E* and actuated by the springs *F*. *G* was the pilot which entered the trays on the downward stroke of the punch in order to insure an equal flange all around.

For the third operation, that of cutting out the bottom, we used a simple blanking die with the stripper fastened to the die at such a height that the work could easily be slipped beneath it.

The result of this operation is shown in Fig. 3, while Fig. 8 shows a detail of the die that was used. The punch was made of tool steel, properly hardened, with the shank turned down to fit the punch holder. Its cutting edge was made a very good fit in the die so that it would remove the stock evenly from the bottom of the spool. The hole through the die *A* was made slightly tapering and of the shape of the inside of the work. The stripper *B* was supported from the face of the die, at a distance a little greater than the thickness of the spool, by means of the cast iron pieces *D D*, which also formed side guides for placing the work in the die. Two pins *E E* were used for a back stop to prevent pushing the piece too far in.

In operation the work was placed on the face of the die, under the stripper, and the punch descending entered the tray and, passing down into the die, cut the bottom from the tray. The hole in the stripper being only .005 inch larger than the punch readily removed the work from the latter, without any wrinkling, on the return stroke.

The manner in which the flange was turned can be seen from the sectional and plan views of the punch and die in Figs. 9 and 10. In Fig. 9 the work is shown in position on the die at *J*, being held in place by the locators *G G*. This die is of the automatic slide type, quadruple in action, the slides being moved in and out in unison by means of inclined faced studs fastened to the punch holder, and springs located in the die base. The cast-iron base *A* has two dovetailed channels planed across the top at right angles to form a bearing for the four slides *B B*, each of which is fitted to slide in its respective bearing, the inner ends being so shaped that on coming together they completely surround the tray and also form a surface on which the flange is turned back when the punch descends. A hardened setscrew and check nut *C* is placed in the end of each slide, for adjustment and to engage with the plunger studs. These slides are forced outward by the springs *D* in contact with the pins *E*, while

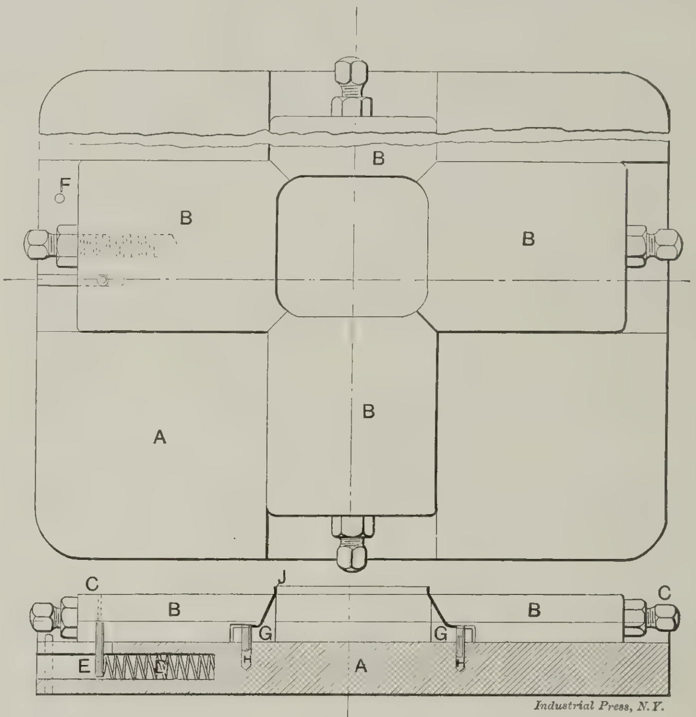


Fig. 9. Plan and Sectional Views of Punch for Turning the Flange.

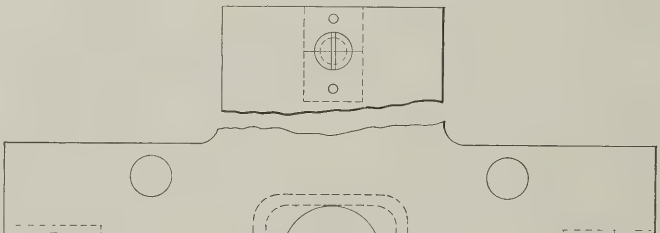


Fig. 10. Plan and Sectional Views of Punch for Turning the Flange.

the pins *F* prevent them from expanding too far. The pins *H H* back up the flanges and check any tendency to spread at this point. The plunger is composed of the four-winged cast-iron holder *K*, Fig. 10, to the end of each arm of which are fastened the inclined studs *L*, and the plunger *M*. Two operations are performed with this punch and die; the first with the flanging punch *M*, which partly turns the flange back as shown in Fig. 4, and the last operation in which the plunger *M* is replaced by the plunger *N*, having a square corner at *R*, and turning the flange squarely back as shown in Fig. 5. An annealing of the lower part of the tray after the bottom was punched out, and between the flanging operations, was necessary to prevent splitting on the outer edge of the flange. C. H. Rowe.

Worcester, Mass.

CAUSE AND EFFECT.

Editor Machinery:

Now and then writers in mechanical papers tell us mechanics how to construct reamers—notably hand reamers. An especial fad seems to be some method of fluting calculated to avoid "chattering," as they tell us. One advocates an odd number of flutes; another an even number, but spaced slightly irregular; while another says spiral fluting remedies the whole trouble. Now it is a fact that reamers with any and all of these methods of spacing the flutes will chatter, or not chatter, according as the real cause is taken account of and guarded against.

What is the primary cause for chattering in the lathe or other machine tools where we use cutting tools? First, too much back rake of cutting tool; and, second, springing of work opposite the cutting tool, allowing it to alternately cut in and jump out. Now in the case of a hand-fluted reamer cut with 10 flutes we have 10 cutting edges, and if the tops of the lands be backed off a considerable amount, that reamer will surely chatter any way you may flute it, because the cause which produces chattering exists therein. But let the tool maker first grind the reamer perfectly round and smooth, and after slightly easing the tops of the lands by the use of an oil stone or other mild means, tone up the front edge to a sharpness sure to cut, and ream your hole, and it is not possible to make that reamer chatter. Don't try to remove a quantity of stock by a finish or size reamer. One-hundredth part of an inch under size for a one-inch diameter reamer is a great plenty of stock to remove; .005 inch is better and avoids much trouble in obtaining a smooth and round hole.

I was employed at one time where they had a full set of hand reamers. Of course, certain sizes used most got dull, and we nick-named them "burnishers," for the reason that they were round and smooth, and though they were dull it was an absolute impossibility to make them chatter in a hole. One day the proprietor took a job of a lot of pieces having a hub requiring a ⅝-inch diameter hole by 3 inches long. He made a preliminary trial with one of these pieces, using his regular ⅝-inch reamer, but it was dull and worked hard, and he remarked that he would have to send for a new ⅝-inch reamer. But I thought I could put it into shape to do the job, and found that by grinding off the front of each land, producing a cutting edge, old "burnisher" did the business smoothly and easily. A notable mechanic of long years of experience tells us that he always grinds his reamers perfectly round and smooth, and to obtain the cutting edge sharpens them by grinding them off in front, and he never has any chattering reamers in his shop. Once any cause is known the remedy is forthcoming. F. W. Clough.

Orange, Mass.

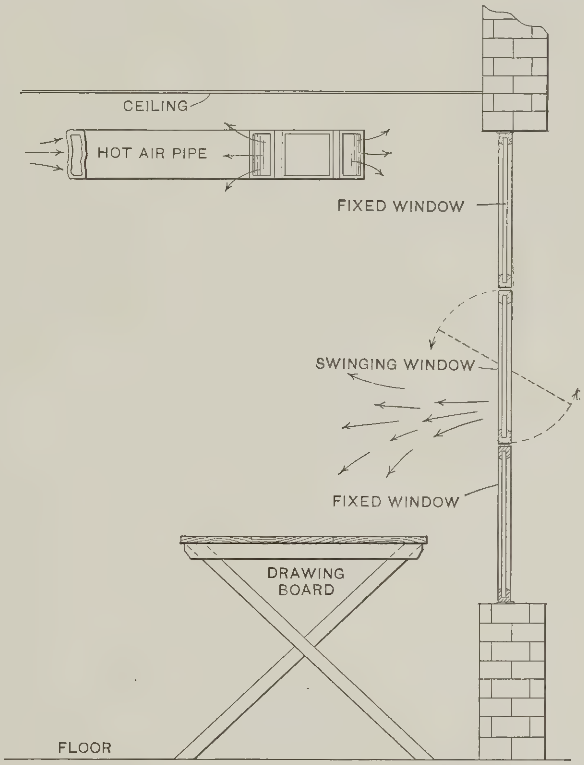
FAULTY CONSTRUCTION OF SHOP WINDOWS.

Editor Machinery:

Looking through some back numbers of Machinery, an article on "Factory Construction" interested me very much; not because I am in the construction business, but that I, as well as others, have been obliged to work in a room where faulty design has hampered my work and injured my health.

The windows are the faulty design I refer to. The company I am employed with keep about fifty draftsmen, and all are located in one large room, heated by the hot-air system. Along the sides near the windows the drawing boards are placed, as many as is convenient; the remainder cover the center of the room. By referring to sketch you will see that the window is about 3 feet from the floor and extends to the ceiling. The bottom and top sections are fixed, and the middle section is hinged at the center, which is the only provision for ventilation. The hot air pipes are close to the ceiling, as are the dampers at the outlet.

In cold weather the heat is turned on until the room becomes too warm. The hot air regulators are high and unhandy to get at, so to cool the room the windows are opened. But the windows being low down, about in line with Mr. Draftsman's head, he very soon finds that he cannot stand the draft blowing on him, and soon closes the window. At the same time Mr. Draftsman in the center of the room is suffocating from the stuffy heat. The man at the window says "Close it;" the man in the center of the room says "Open it," and the result is trouble. It is not uncommon to see two-thirds of the men along the windows suffering from cold or at home sick. During the very cold weather it is necessary to cork along the edges of the frames to keep out the cold.



Industrial Press, N.Y.

If the editor sees fit to insert this letter and it meets the eye of the designer of these "so-called windows," I, one of the many sufferers, hope to see a practical window designed. Think of those who are obliged to work in rooms nine or ten hours with these glass traps! Insurance inspectors are not the only persons in this world.

Draftsman.

* * *

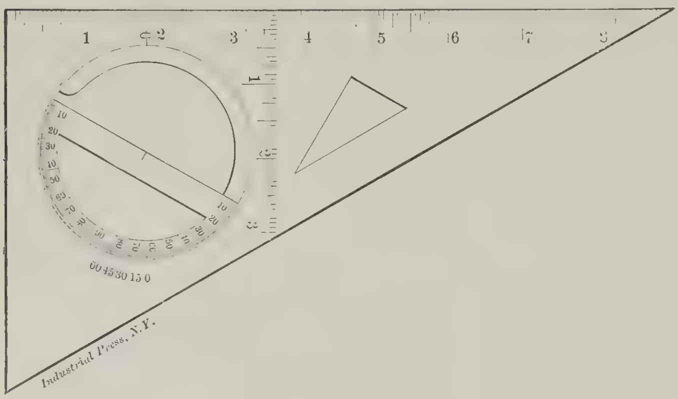
CONTRIBUTED NOTES AND SHOP KINKS.

GRADUATING TAILSTOCKS.

H. A. Mears writes: I have this suggestion to offer anent the somewhat lengthy description of a graduated tailstock spindle which appeared in the August number of Machinery. Instead of going to the trouble of making lines all around the tailstock spindle, I screw the spindle back as far as it will go and make a mark on the side or top flush with the face, then run it out another inch and make another mark. This is continued for the whole length of the spindle and then the divisions are subdivided as desired. This accomplishes the same result without the necessity for removing the spindle from the tailstock. With a sharp pointed tool I have drawn a horizontal center line on the front side of the spindle and find this very handy for setting tools.

COMBINATION TRIANGLE AND PROTRACTOR.

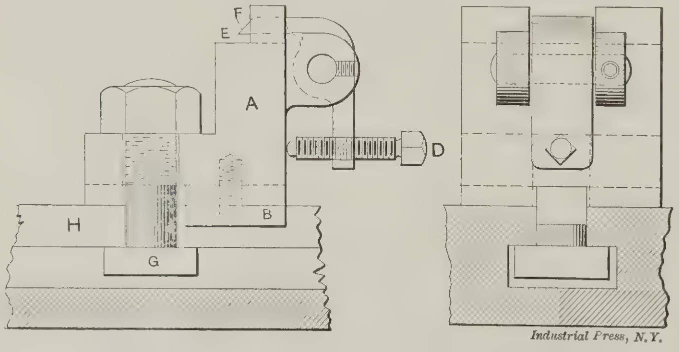
E. A. C. sends us the accompanying sketch of a celluloid triangle which he has constructed, and is finding very handy for drafting room use. The lower side is graduated in sixteenth inches, and by moving the T-square up and down, lines may be drawn and scaled at the same time. Vertical lines up to three inches apart can be drawn very accurately if a little care is taken when the graduating is done. The protractor, although small, will be found useful to quite an extent. It can be purchased of any dealer in draftsmen's supplies and after the edge is beveled it can be sprung into the circular recess previously bored in the body of the triangle.



Industrial Press, N.Y.

A DEVICE FOR CLAMPING FLAT WORK.

"Student" sends the accompanying sketch of a clamping device for use on planers, shapers, or milling machines for holding flat pieces of work. This clamp is bolted to the platen *H* with the bolt *G*, and the bottom of the casting is planed with two slots for the key *B*. One of these slots runs lengthwise and the other crosswise so that the key can be set at right angles to the travel of the table, thus offering greater resistance to the milling cutter; or it may be set parallel with the table and thus bring both dogs in line.



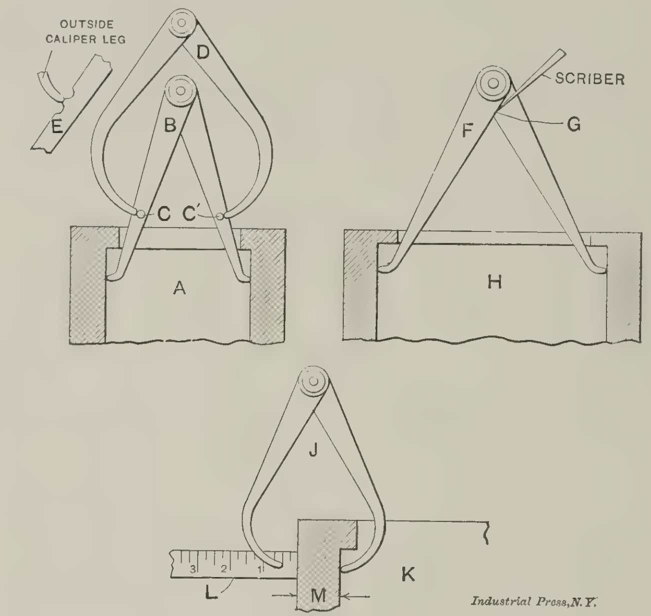
Industrial Press, N.Y.

These clamps are used for holding such work as valves, valve-seats, flanges, or any flat work which is placed down on the seat *E;* the setscrew *D* is then tightened, thus forcing the steel point *F* downward and into the work. The same operation performed upon the other end securely clamps the work.

SOME MAKESHIFTS WITH CALIPERS.

Of course the machinist who is up-to-date has a set of transfer calipers so that he is able to take measurements over flanges, etc., but it sometimes occurs that these convenient tools are not at hand when such measurements are to be taken. This is likely to occur on repair jobs when only the most necessary tools have been taken along. In such cases the accompanying cuts show some of the makeshifts that have been used. To measure the inside diameter of a bore having a shoulder like the piece *H* the inside caliper *F* is set as usual, and then a line is marked with a sharp scriber on one leg by drawing it along the side *G*. Then the legs are closed to remove the caliper, and are reset to the scribed line. Of course this method will only do for an approximate measurement, but it is surprising how close it may be made if care is taken, especially on small diameters with large calipers.

Close measurements may be made by filing two notches in each leg so as to leave a rounded projection between, as shown at *E*. Then with an outside caliper, *D*, the setting of the inside caliper, *B*, is taken from the rounded points. The inside caliper can be reset very accurately after removal by this method. A still better way is to have two short pins, *C C'* set in the sides of the inside caliper legs, but this is not readily done as a makeshift.

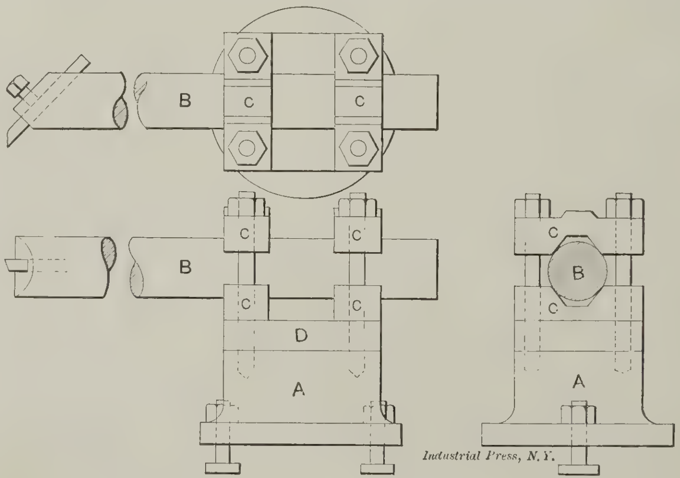


Industrial Press, N.Y.

To get the thickness of a wall beyond a shoulder as at *K* set the caliper so that the legs will pass over the shoulder freely, and with a scale measure the distance between the outside leg and the outside of the piece. Then remove the caliper and measure the distance between the caliper points. The difference will be the thickness *M*. **E. R. F.**

A HANDY BORING BAR HOLDER.

J. C. W. B. sends a sketch of a boring bar holder that will commend itself to the lathe hands who have been troubled by springing, chattering and digging in of the ordinary tool on heavy work. The bar *B* is firmly secured by two pairs of V-clamps *C*, which are fastened by studs to the main casting *A*, the latter being bolted to the cross slide of the lathe in place of the compound rest. The bar shown is 2½ inches in diameter, but smaller ones can be used in the same holder by blocking up the lower clamps. For facing off work or for ordinary turning the upper clamps and bar are removed and the tool inserted between the lower clamp *D* and the base *A* in the same manner as in the tool holders of the heavier lathes and planers



Industrial Press, N.Y.

* * *

Liege, Belgium, is one of the greatest industrial cities of Europe and is world-renowned for the quality of its firearms and gun barrels.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

17. H. J. inquires in regard to the use of shade lines, whether the additional weight to the line shall be added to the inside or outside of the boundary lines, raising the point that unless some definite rule is followed confusion will arise, when scaling a drawing, as to which side of the line is to be scaled.

A.—We do not think that there is any rule that is generally followed in drafting rooms, since shade lines are usually used only on detailed drawings on which the dimensions are given so that scaling is unnecessary. If, however, a definite rule is to be followed it should be to place the shading on the side of the line farthest from the source of light. There are a number of theories regarding the use of shade lines but in practical use the rule is to shade the bottom and right-hand lines, on the assumption that the light strikes the object at an angle of 45 degrees, from the left. In Figs. 1 to 3 this principle is illustrated with shade lines of exaggerated weight. In Fig. 1 the light comes in the direction of the arrows, at an angle of 45 degrees and consequently casts a shadow, or makes a shade line from *a* around *b* to *c*. On the inside of the hole the same principle would apply, thus causing the shade to be placed on the inside of the hole. In shading a circle the shade would be drawn with the same radius as the circle but with the center shifted to the lower right-hand on a 45 degree line, as from *A* to *B*, Fig. 2.

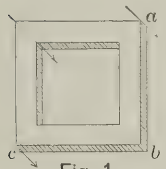


Fig. 1

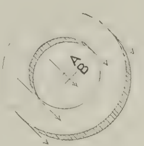


Fig. 2

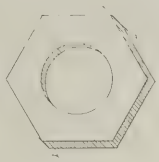


Fig. 3

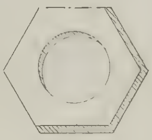


Fig. 4

Industrial Press, N.Y.

Another reason for putting the shade lines on the outside of the boundary lines is that the outline of the figure is not thereby distorted. Figs. 3 and 4 show two views of a hexagon nut blank which have been shaded in both ways. In Fig. 3, which is correct, the shading is on the outside of the lines and it will be seen that the outline of the figure remains in its true proportion, while in Fig. 4, where the shading is placed on the inside of the lines, the outline of the figure is considerably distorted.

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18. E. W. G.—When the crankpin of an engine is at the top quarter and the crosshead moving toward the cylinder, is the engine said to be running "over" or "under?" Why is an engine said to be running "under" or "over?" How can it be determined in an engine of the Westinghouse type which way it is running?

A.—The terms "running over" and "running under" are or should be applied only to horizontal engines, as they are meaningless when applied to vertical engines. Stand back of the engine cylinder (that is, back of the rear head) and look toward the shaft. If, while the crosshead is moving away from the observer the motion of the connecting-rod is entirely above the center line; or in other words, if the connecting-rod appears to pass over rather than under the axis of the shaft, the engine is said to be running over. If the reverse is true, the engine is running under. To answer your first question directly, the engine in that case would be running under; but if the crank were at the top quarter while the crosshead was traveling away from the cylinder, the engine would be running over. Why these expressions are used we do not know and can only guess. It is natural to consider the outward stroke of an engine as the leading stroke, and when the connecting rod appears to the eye to be passing over the shaft center during this stroke, it is natural to speak of the engine as running over. One obtains a distinctly different mental impression in watching an engine running over from what is received when it runs under. We believe the terms have come naturally as a result of these impressions. With vertical engines the effect on the eye is the same, whichever way the engine is running. The connecting rod, being suspended from above, does not appear to be passing over the shaft center when running in one direction more than when running in the other direction.

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19. C. W. J.—Kindly give me your opinion on setting up an emery wheel in a shop. Should it be so placed that the man who is grinding is facing the light (that is, a window), or so that his back will be toward the window? Also, the same question with reference to the location of a lathe. Our lathes are all set so that our backs are toward the windows. Is this the right or wrong way, and why?

A.—The question of the location of a tool near a window appears to be a question of which is the lesser of two evils. With the workman's back to the window he stands constantly in his own light. With the workman facing the window, he will find that the work itself is always in its own light; or in the case of the grinder, that the wheel tends to cast a shadow over the tool. In shops having plain glass in its windows, the light is likely to be glaring and disagreeable to one facing windows on the sunny side; but with the modern corrugated glass, or with suitable shades at the windows, this is not serious and the writer of this note prefers to face the light when working at a tool. One reason is that it is sometimes convenient to be able to "see light" between contact points, when calipering, etc. The ideal way is to locate the tool at an angle of 45 degrees with the window, so that the workman stands with his back and one side turned partly toward the window. The light then reaches the point where the tool is operating and no shadow is cast. Other and more important considerations, however, make it inconvenient to have tools placed in this manner. We should be pleased to have the opinions of readers upon this subject of tool location.

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20. L. M. O.: What is the difference between a plug valve and a piston valve as applied to steam engines?

A.—A plug valve is a cylindrical valve that works in a direction parallel with its axis, and is made with no means of adjustment to compensate for wear. Plug valves work well when new if accurately fitted, especially on vertical engines, but the inevitable wear soon makes them very wasteful because of the great leakage of steam. A piston valve is a cylindrical valve similar to a plug valve but provided with expansion packing rings to follow up the wear. The chief advantage of the plug and piston valves over the D-valve is that they are in perfect balance at all points of the stroke, but with steam-set packing rings the piston valve is far from being frictionless. In fact, it is said that in some cases locomotive piston valves work as stiffly as the old unbalanced D-valve. This defect has led to the invention of the American semi-plug valve which is a piston valve made so the packing rings are free to follow up wear when steam is shut off. When steam is admitted, the packing rings are instantly locked solidly in position so that no further expansion can take place, thus practically converting it into a plug valve for the time being.

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21. T. R. M.—Will you please tell me how many flutes should be cut in an ordinary straight reamer, and advise me whether it is better to use an even or an odd number of flutes.

A.—It is never best to use less than five flutes for, if a less number be employed, the reamer is apt to follow any irregularities in the bore and fail to produce a round hole. With five or more flutes the reamer is not able to follow these irregularities, so as large a number of flutes should be used as the size of the reamer and the strength of the blades will permit. If an even number of flutes, evenly spaced, are used, there is a tendency for the reamer to vibrate, since in reaming irregular holes the greatest load will come on two opposite blades; for this reason it is customary to use an odd number of flutes which results in the greatest load being carried upon at least three teeth. The same result is also obtained by employing an equal number of teeth, but spacing them irregularly.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

HEAVY GRINDING MACHINE.

The Norton Grinding Machine Co., Worcester, Mass., have extended their line of heavy grinding machines by placing on the market an extremely heavy 18-inch machine, for work having a length up to 14 feet between centers and weighing up to 7,000 pounds. This machine for this diameter of work has heretofore been built only for work up to 96 inches long. The weight of the machine complete is about 22,000 pounds. The base is 22 feet long, and weighs 10,500 pounds. The spindles in head- and tail-stock are massive, having center holes three inches in diameter. The wheel spindle and its bearings are mounted upon a slide at the rear of the bed, and weigh, with attached parts, about 1,400 pounds.

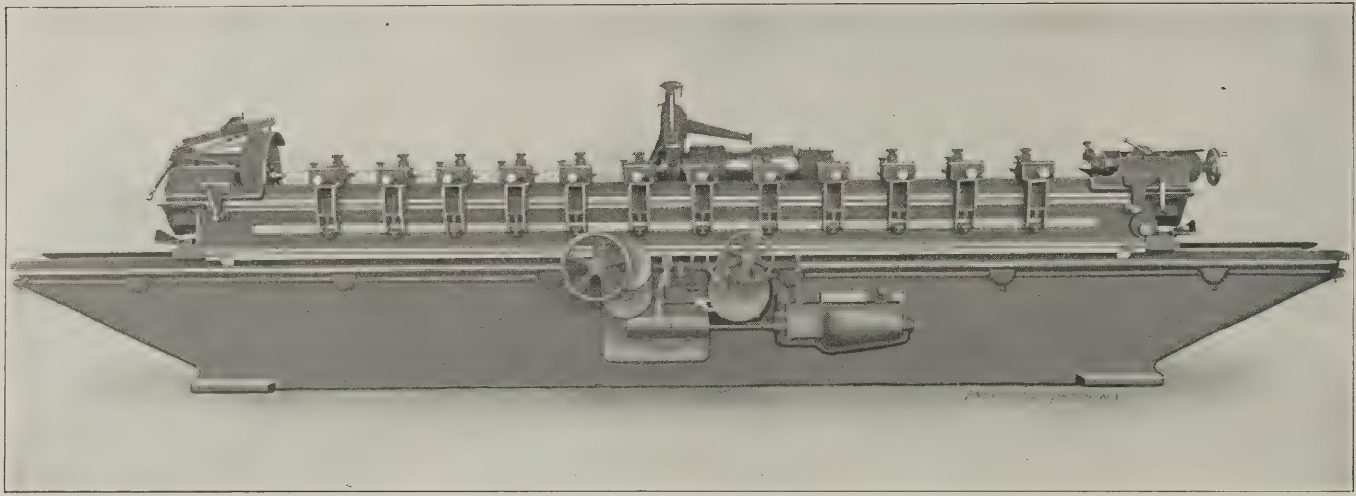


Fig. 1. Norton Heavy Grinding Machine.

Fig. 1 is a front view of the machine, and Fig. 2 an enlarged view of the mechanism seen near the center of Fig. 1, the covers being removed to show the cone, gears, etc. At the right, in Fig. 2, is the speed frame containing speed cone and gears for regulating the speed of traverse of table. By the use of the gearing in connection with the cone fourteen changes of speed are available for the table.

This speed cone drives the gear mechanism seen at the left in Fig. 2 and shown removed from the base in Fig. 3, this mechanism serving to move the table either by hand or power, automatically reversing at the end of the travel.

The group in the center of Fig. 2 is for the movement of the emery wheel forward or back. The extent of the movement is governed by a small dial and crank shown near the top of the index wheel in Fig. 2. The dial has eight holes, equally spaced, and when the ball handle at the center is screwed up tight the lever on which the dial is fixed is made fast to the stud. The operator may then move the emery wheel forward or back by turning the small crank seen on the dial, the movement of the crank from one hole to another giving a change of diameter of work of one-quarter thousandth of an inch. When the ball handle is released the wheel may be moved to or from the work by means of the machine handle at the bottom of the index wheel. This index wheel has teeth on its periphery, which mesh with a small pinion on the axis of the small crank on the dial. The teeth also serve as ratchet teeth, and when the pawl shown at the left of Fig. 2 is thrown into contact, the wheel is fed to the work automatically, a certain definite distance.

The index gear wheel has upon its hub a pinion which meshes with a larger gear, and this gear is fast to the end of the cross-feed screw which passes underneath the work and to the cross slide carrying the emery wheel. In Fig. 4 is a partial side and rear view of the index wheel and cross-feed screw, which latter is of high carbon steel, 3½ inches diameter.

This screw has a bearing in the bracket at the right, Fig. 4, and also a half-round bearing in a massive casting, bored and finally scraped to fit the screw. The combined tops of the thread are equal to a bearing of steel 3½ inches in diameter by 4 inches long, this, however, being distributed over the entire length of 18 inches of the threaded portion.

The half-round bearing for the screw is fast to the under side of the cross slide base and underneath is an oil channel and oil pocket which provide for the lubrication of the screw.

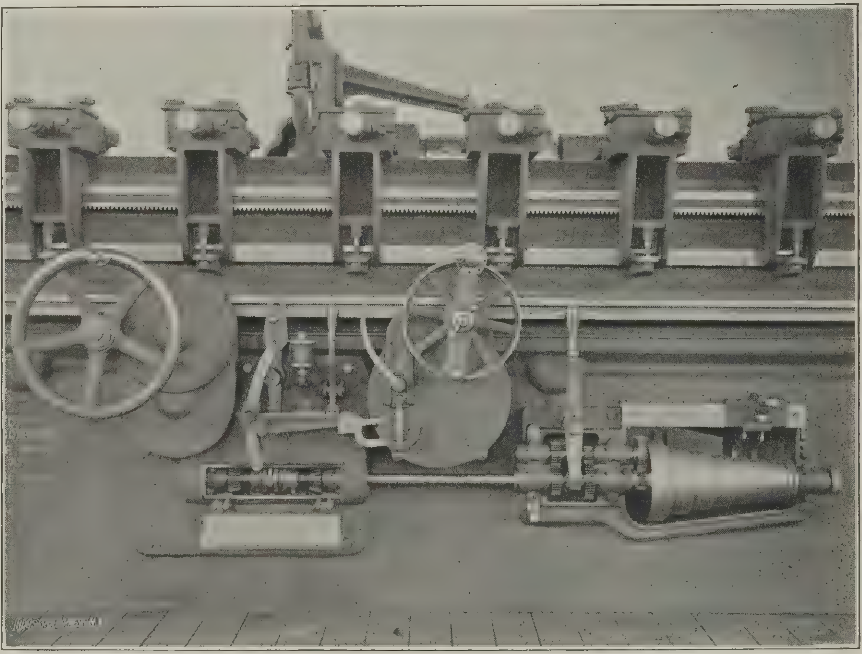


Fig. 2. Enlarged View of Mechanism, showing Cone, Gears, Etc.

The nut for the screw is a half nut 10 inches long, fast to the wheel slide, and its threads are accurately scraped to have a uniform bearing on the threads of the screw. The thrust of the screw is taken by its point, which is beveled and bears against a bronze plug imbedded in a very massive casting. The bearing for the screw being on the anvil principle, and the thrust plug being imbedded in an anvil, so to speak, make it possible to index for one-quarter thousandth diameter and to move the wheel slide one-eighth thousandth inch accurately. The screw, if moved at all, must revolve; it cannot swing to the right or left, or bend down away from the nut.

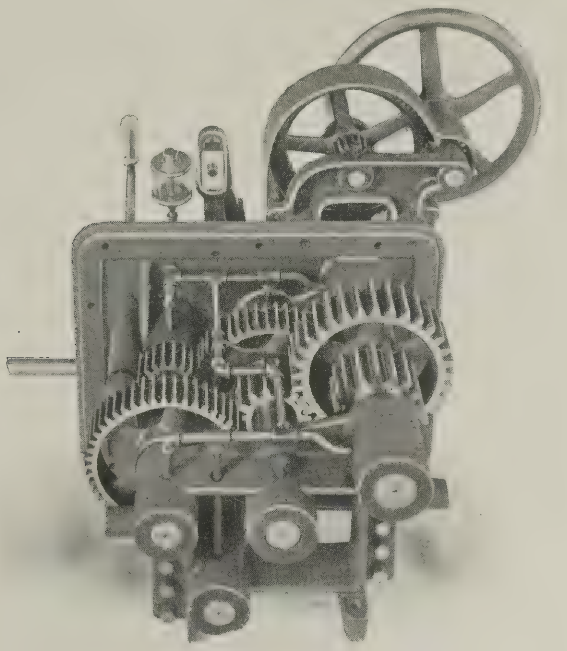


Fig. 3. Detail of Gear Mechanism.

It is possible with this machine to remove any amount of material from steel from a quarter thousandth up to four or five thousandths on the diameter, according to the area of the surface of the work, and obtain accurate measurements automatically or by hand indexing.

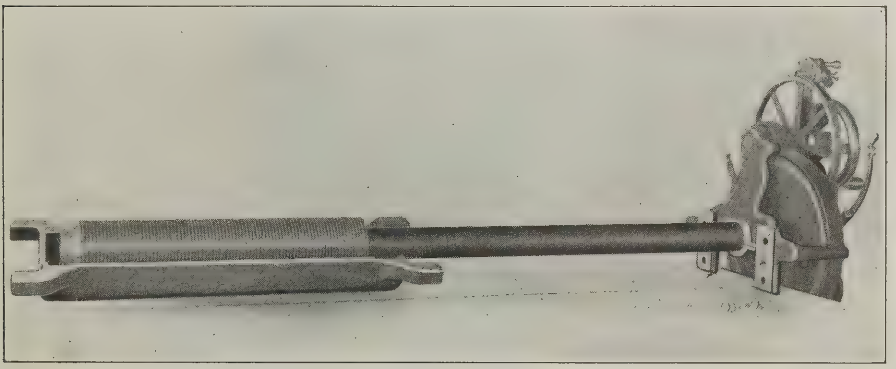


Fig. 4. Index Wheel and Cross-feed Screw.

We are informed that an operator, after measuring the work for a given size, and then setting his micrometer five thousandths under this size, can set the machine to grind off that amount of stock automatically without any "cut and try" business. Then, when the machine has completed the work according to the setting, the latter will be found exactly to size, according to the setting of the micrometer.

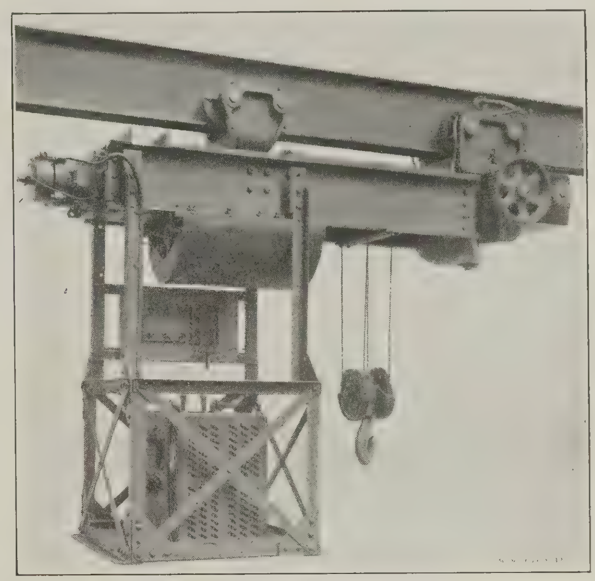
The motion of the table is started and stopped by the lever shown near the oil cup. At the left of this oil cup is the reversing lever. It will be seen by this grouping of mechanism that the operator can adjust the position of his wheel for measuring the work, change the speed of his table, stop and start the table, reverse the table by hand, move the table by the handwheel and adjust the steady-rests, which are shown at the top of the picture, without moving from one point, whatever the length of work may be.

The revolution of the work is varied by a movement of the slide at the top of the head stock, which guides a belt up and down the cone.

The head- and foot-stocks of this machine weigh about 400 pounds each. The swivel table, with its mate, the sliding table, weigh about 5,500 pounds. These, with the large number of steady-rests furnished, form a moving anvil upon which the work revolves, which is sufficient to prevent vibration when the wheel is worked up to the capacity of the power in the machine. This latter is sufficient to remove from nearly all diameters, 1 cubic inch of steel per minute.

NEW ELECTRIC TRAVELING HOIST.

The Niles-Bement-Pond Co., at their crane department in Philadelphia, are building a new style of electric traveling hoist, which we illustrate herewith. The hoisting mechanism is placed between the channel framing of the trolley and is direct geared to the drum, a standard load and motor brake being provided. The power for hoisting is furnished by electric motors, in all cases, while the travel may be arranged for by motor or hand racking. Where curved tracks are used swivel trucks will be furnished. The hoist is built in three sizes, of 3, 4 and 10 tons capacity. It may be equipped with a cage, as shown, or arranged to be operated from the floor by means of pendant controllers.



New Electric Traveling Hoist.

NEW TEN- AND TWELVE-INCH SPEED LATHES.

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., manufacturers of the "Star" screw-cutting engine lathes for foot or other power, have placed 10- and 12-inch speed lathes on the market, one of which is shown below. The spindle is made from a crucible steel forging, has a large hole and runs in phosphor bronze bearings which are self-oiling and dust-proof. Each bearing is oiled by a double set of wicks, and the surplus oil runs back into the oil wells,

New Speed Lathe.

which prevents dripping and waste of oil. After once oiling, the lathe will run for a long time without attention in this respect. The cone pulley is turned inside as well as outside, producing perfect balance. The tailstock is of the curved or cut-under pattern, and the tail spindle has a new combination screw-and-lever motion, with graduated dial. The dial is graduated to sixteenths, is useful for drilling, counterboring, countersinking, etc., to a desired depth, and can be moved and set at any point. To change from screw to lever motion the thumb-screw is loosened, which releases the spindle sleeve. The long hand lever can be lifted off when not in use. A hand-rest is provided, with short and long T-rests; rest socket and saddle are locked to the bed by a cam-locking device, and T-rest is held in the socket by a friction clamp, doing away with the setscrew commonly used. These rests and the tailstock clamp are operated by levers, always attached, so that no wrenches are required.

The bed is provided with a flat front way and with a back way that is V-shaped, as in the "Star" engine lathes. Secured to the back of the bed is a shelf for the reception of tools, etc. The countershaft has self-oiling and self-aligning shaft bearings; and tight and loose pulleys, or friction clutch pulleys are furnished, as desired.

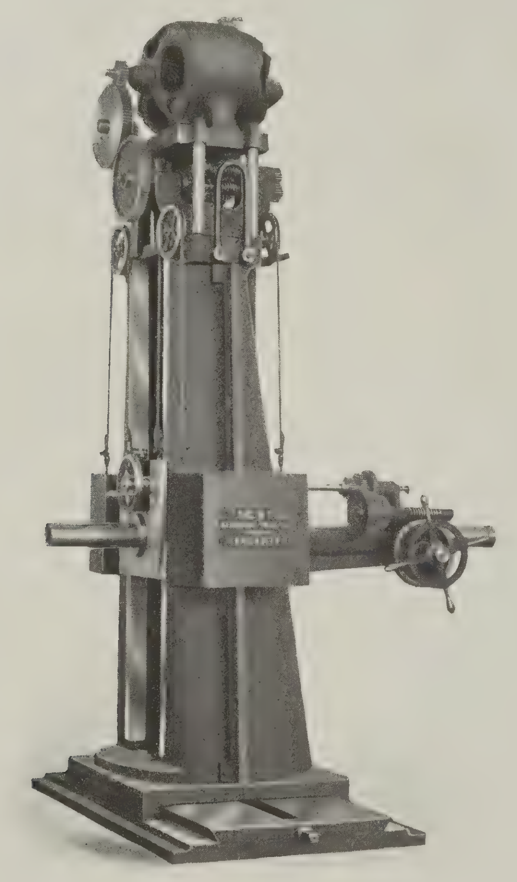


Fig. 1. Newton Portable Boring, Drilling and Milling Machine.

Each lathe is provided with faceplate and two point centers; and, when specified, slide rests, draw-in chuck, collets, etc., are supplied. The lathe can be furnished mounted on oil-pan or bench legs; also with foot power in place of countershaft.

PORTABLE SLOTTER AND PORTABLE BORING, DRILLING AND MILLING MACHINE.

We illustrate herewith two new machines brought out by the Newton Machine Tool Works, Inc., Philadelphia, Pa. One is a portable boring, drilling and milling machine, the other a 48-inch portable slotting machine. The boring, drilling and milling machine, Fig. 1, is specially adapted for work on large electric motors and dynamos. It has a boring bar 4¼ inches in diameter, with an automatic feed of 39 inches, with three changes, a hand feed and a hand quick return. The spindle head is counterweighted and has power quick movements in the upright, operated independent of the spindle, in either direction, by reversing the motor. It also has two changes of automatic feed, for milling. The speed changes are obtained mechanically by changing the gearing between the motor and the driving shaft.

The uprights have an adjustment on the base of 30 inches. The maximum distance from center of spindle to floorplate is 6 feet, 10 inches; the minimum distance, 22 inches. The machine herewith has a fixed upright, but it may be made with a swiveling upright when desired.

The slotting machine, Fig. 2, is for very heavy work beyond the range of regular slotting and planing machines. The ram of the machine is counterweighted, the counterweights running inside the frame, and it has a stroke of 48 inches. The ram is driven by a spiral rack and pinion, by means of a 10 H. P. motor, the reverses being operated by a magnetic clutch, which makes the machine very compact. The tool slide has a cross feed of 30 inches and an in-and-out adjustment of 4 inches.

This machine can be clamped in any position on the floorplate to suit the work, and is also made on a sub-base, giving an adjustment to the entire upright without unclamping it. It is especially adapted for work on dynamo frames and rings and can be used to advantage in the manufacture of large engines.

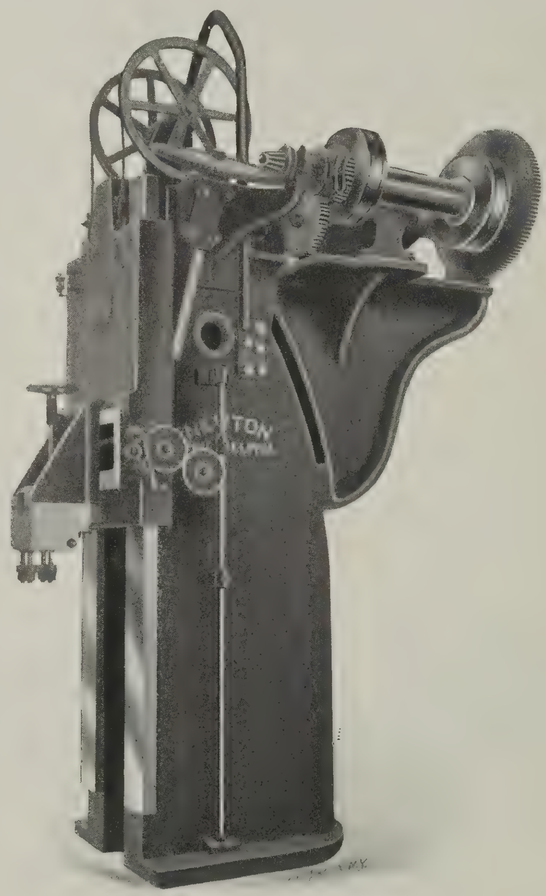


Fig. 2. Newton Portable Slotter.

NEW CUTTER GRINDER.

The Heald Machine Co., Worcester, Mass., have brought out a wet cutter grinder for grinding formed cutters, gear cutters, hobs, taps, forming tools, etc., and which is also fitted with an attachment for grinding lathe and planer tools. It is the experience of this company that cutters ground with a dry wheel, after the usual custom, do not stand up to the work as they should, even when the greatest care is taken in grinding; and the conclusion was reached that it would be more desirable to grind cutters in the presence of an abundance of water, so that there should be no overheating at the cutting edge, even when grinding off the relatively large amount necessary in cutters of this form. It was believed that water is as necessary in cutter grinding as in the cylindrical grinding of general machine work.

The results of the company's experiments are embodied in the machine shown in Fig. 1, next page. It consists of a base and column provided with a grinding wheel mounted in a double carriage at the top, and a square trough-shaped casting, adjustable up and down on the front of the column, in which the work holder is carried. This work holder can be swiveled to any desired angle with the wheel, and placed either in a right-hand or left-hand position.

A swivel head is also provided and the machine is adapted for grinding all kinds of milling cutters, both angular and plain, as well as for grinding forming tools.

The tooth rest (see detail view, Fig. 2), instead of being flexible, after the usual construction, consists of a short rod which can be adjusted out or in for setting the cutting faces against the wheel, for the purpose of giving a very rigid support to the cutter tooth while grinding. The finger swings out of the way to the right or left, to allow the cutter to be turned upon its axis. The wheel is traveled through the work by the hand lever at the side of the column. The work is raised and lowered by means of the hand-wheel and screw, which gives a quick and accurate adjustment of the work to the wheel. A water tank at the base of the column, with a centrifugal pump, furnishes an abundant supply of water to the work; while water guards are provided to keep the water where it belongs, so that the other parts will remain dry and in good condition.

The work holder, while simple, is quite universal in its range and will hold both straight and taper spindles, right- or left-hand cutters, whether straight or angular; also flat forming tools, threading cutters, etc., which are ground on their faces in sharpening.

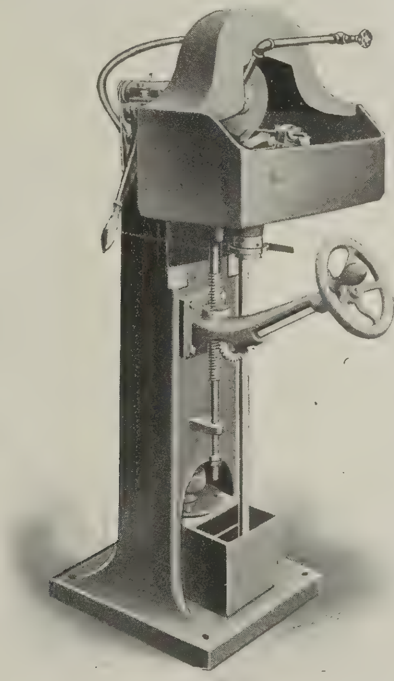


Fig. 1. Heald Wet Cutter Grinder.

The attachment for grinding lathe and planer tools, shown in Fig. 3, consists of an L-shaped casting which will swivel on the base to any angle. It carries a spool for holding the tool, which will also turn about the axis of the tool, these two adjustments giving practically any setting needed for such work. Each axis of the holder is fitted with a graduated dial, and the point of the tool can be elevated or depressed to any required angle within the spool, which gives additional adjustment.

The machine is furnished in three styles: One, for cutters, etc., alone; another, for cutters with the tool grinding attachment, and a third, for grinding tools only.

LARGE AUTOMATIC GEAR CUTTING MACHINE.

What is said to be the largest entirely automatic gear-cutting machine ever built has just been completed by Gould & Eberhardt, Newark, N. J., for the R. D. Nuttall Co., Pittsburg, Pa. The company state that there have been larger machines manufactured for this class of work, but these have been of the semi-automatic type, whereas this machine after once being set and started needs no further attention until the gear blank is completed.

The machine is shown on the following page. Being designed for coarse-pitch, heavy gearing, it is arranged so that the gear blank will lie down flat on the ways of the bed, instead of being supported on an arbor, between two upright columns, as in their smaller machines. This makes a very rigid support to the gear blank; the machine is laid out on the anvil principle, to carry the weight, take the strain of the cut and absorb vibrations when cutting.

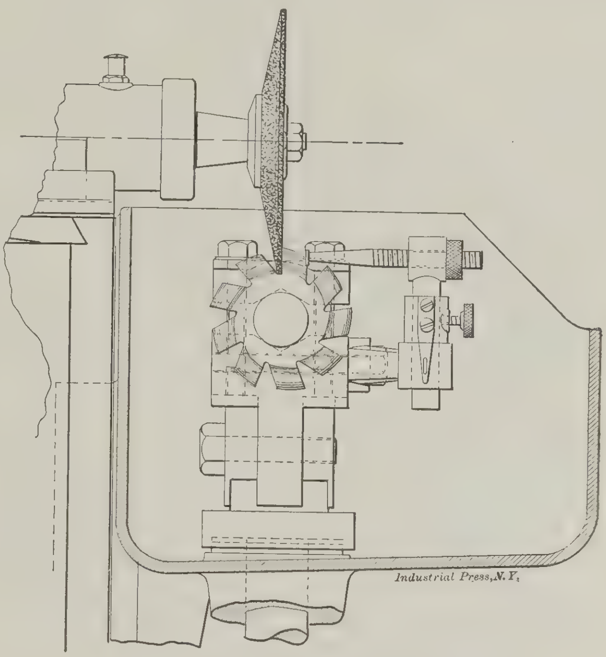


Fig. 2. Enlarged View of Cutter Grinder.

The cutter slide works up and down in a vertical position, on an upright stanchion, which is movable longitudinally on the bed either by hand or power. The work barrel and arbor, and also the worm dividing wheel, are rigidly fixed to the machine bed; and the positioning of the cutter in relation to the gear blank is obtained by moving the upright stanchion on the bed. Its exact movement to a fixed distance is located by means of a graduated dial and scale, with a stop which can be set at any predetermined point.

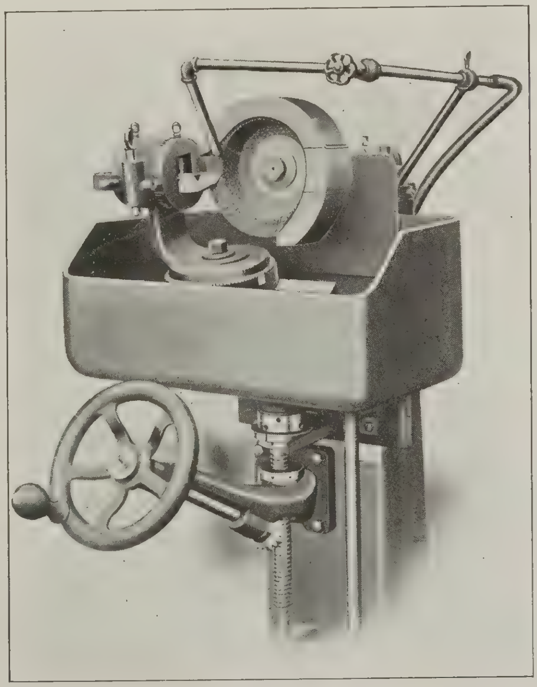


Fig. 3. Attachment for Grinding Lathe and Planer Tools.

The cutter slide has a long and narrow guide flat bearing on the ways. It is counterbalanced by a 3,000-pound weight, held by two cables which pass over double grooved pulleys mounted on top of the stanchion. The cutter spindle has a powerful worm and wormwheel drive, and in addition to the regular cutter spindle for the use of large-diameter, coarse-pitch cutters, an auxiliary cutter spindle is furnished for using cutters up to as coarse as 1 diametral pitch. The bearings for the cutter spindle are heavily proportioned.

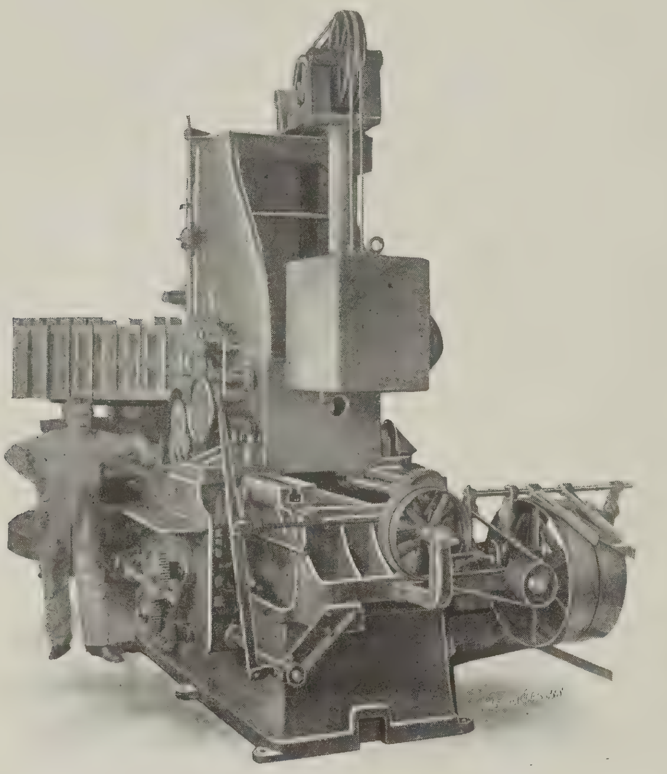


Fig. 1. Rear View showing Counterbalance and Driving Gear.

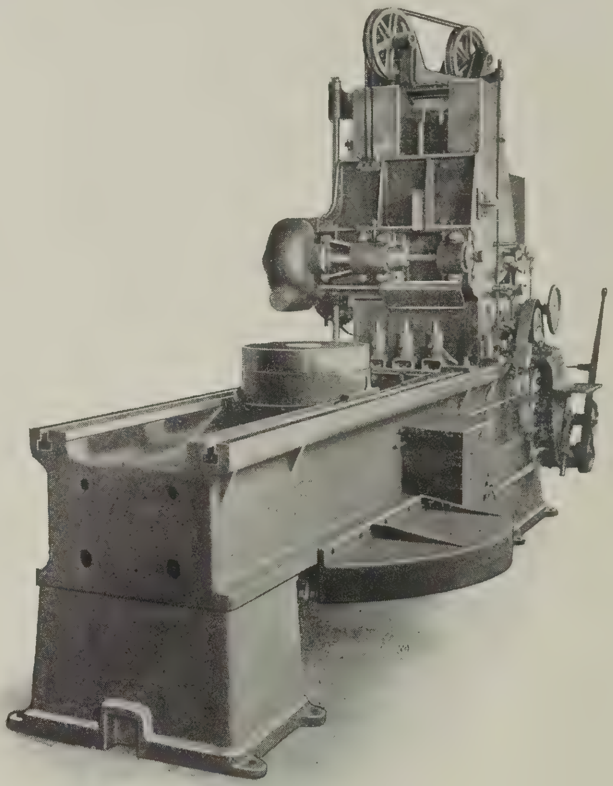


Fig. 2. Front View of Automatic Gear-cutting Machine.

The worm dividing wheel is of large diameter and as is the practice with the company's smaller gear-cutting machines, it is made in halves, doweled together and hobbed. A guard protects it from all chips and dirt, etc. The chips, and also the lubricant used for the cutter, drop into a compartment below, the lubricant being separated by gravity and flowing into a pocket in the base from which it is again pumped to the cutter.

Divisions for the different numbers of teeth are arranged to be made entirely automatically through combinations of gears, but the machines can also be arranged so as to be operated semi-automatically, and the dividing mechanism tripped by hand for each tooth, if desired. In a test made of a 10-foot gear blank cut in this machine, the greatest error between any two teeth was .0015 inch.

Only one belt is used to drive the entire machine, and all movements are actuated through splined shafting and gearing. Each movement is complete in itself, and cannot take place unless all previous movements have been fully and correctly completed. A very essential feature of the con-

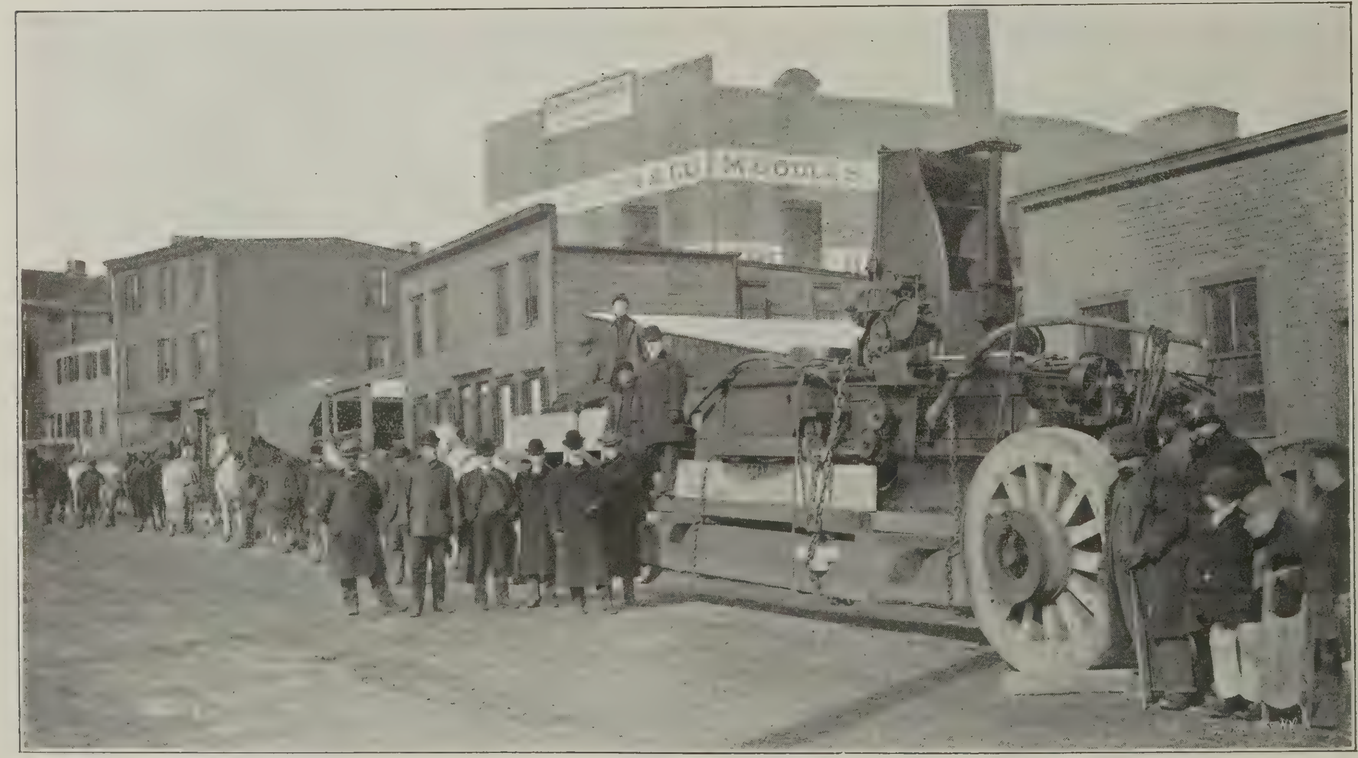


Fig. 3. Gould & Eberhardt 40,000 pound Automatic Gear Cutter being Hauled to the Car by a Team of Fourteen Horses.

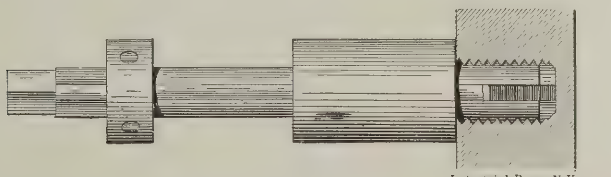
struction provides that unless the division of the worm-wheel is made complete, the cutter carriage cannot possibly feed forward. This always takes place entirely automatically, and requires no adjustment whatever, for any size of gear.

ELECTRICALLY-DRIVEN TRAVERSE SHAPER.

The accompanying half-tone engraving shows a single head traverse shaper, built by the Cincinnati Shaper Co., Cincinnati, Ohio, as it has recently been equipped for motor-drive. The motive power of this shaper is furnished by a 7 horse power Crocker-Wheeler variable speed motor operating on the four wire system, which is attached to the base at the rear of the machine. The pinion of the motor shaft meshes into a gear on an intermediate shaft carrying a positive clutch which may be thrown into one or the other of two sets of gears connecting with the driving shaft of the machine. The controller for the motor is mounted on a bracket attached to the saddle and is shown at the left-hand end of the saddle in the illustration. With this method of attaching the controller the operator has full control of the machine when standing in position in front of it, as on these shapers all of the feeds are directly operated from the saddle. The electrical connection of the controller with the motor is shown in the line drawing, Fig. 2. The wires from the controller are supported over the bed of the machine by being placed in a piece of wrought iron pipe that is attached to the saddle at the rear of the controller. The wires from this box to the motor and to the panel stand, which is placed at the right of the machine, are likewise enclosed in pipe so that all danger of injury to any of the connections is prevented. This machine has a capacity for taking work up to 24 inches in width and 8 feet in length.

BROKEN-TAP REMOVER.

The cut herewith shows a device which is adapted to engage and remove pieces of taps which have been broken off in a tapped hole. It consists of a cylindrical holder whose diameter is equal to that of the tapped hole, and is provided with a square section at one end to receive a wrench. The holder has longitudinal grooves, corresponding with the longitudinal grooves in the tap, and which receive the sliding tap engaging bars. These bars are fixed at their upper ends in a sliding collar by which they are moved lengthwise on the cylindrical holder. A loose sleeve slides on the holder, and when the remover is applied to a broken tap the sleeve is slid down close to the work, supporting and holding the tap engaging bars in their respective grooves, at the point where the strain is applied.


Industrial Press, N.Y.

Broken-tap Remover.

The manufacturers of this device, the Atlas Machine Co., Providence, R. I., state that this device is simple and strong. It engages the broken piece, unscrewing and removing it without damage to the work, and is always ready for instant use. It is made in a set of six sizes, for standard taps, from ¼ to ⅝ inch, and other sizes are made to order.

TWO SIDE TOOLS.

The accompanying illustrations show two new side tools, consisting of holders with specially-shaped cutters of self-hardening steel. One of these tools is offset and is made both right- and left-hand; the other is a straight-shank tool, either right- or left-hand. The holders are drop forgings, of steel, and casehardened, and have dovetail grooves for the reception of the cutters. The depth of the groove and the thickness of the cutters are the same, so that the outer surface of the cutter does not project beyond the outer surface of the holder. The clamp screw bears against the lower beveled edge of the cutter and has a countersunk head which is flush with the surface of the holder. The clamp screw is so near the edge of the holder that the cutter can be used up very short. These tools, made by Armstrong Bros. Tool Co., Chicago, Ill., are supplied in sizes up to 1¼ to 2¼ for the offset tool, and 1½ by 2⅜ for the straight shank tool. The former tool is designed especially for lathe work, and the latter for planer work.

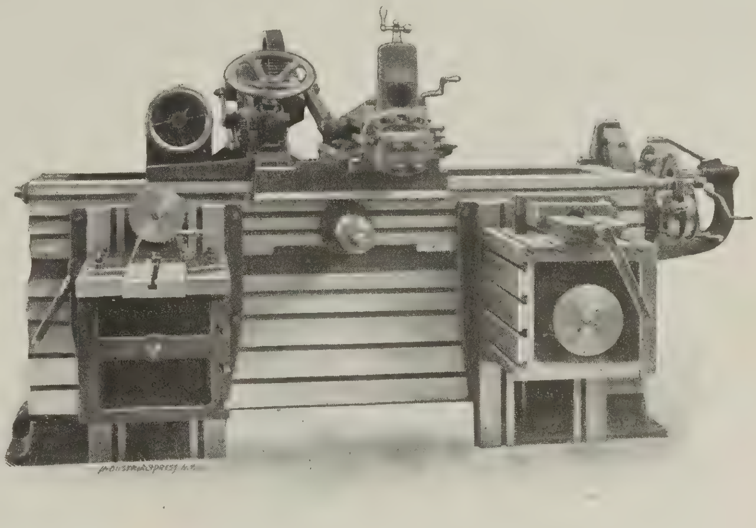
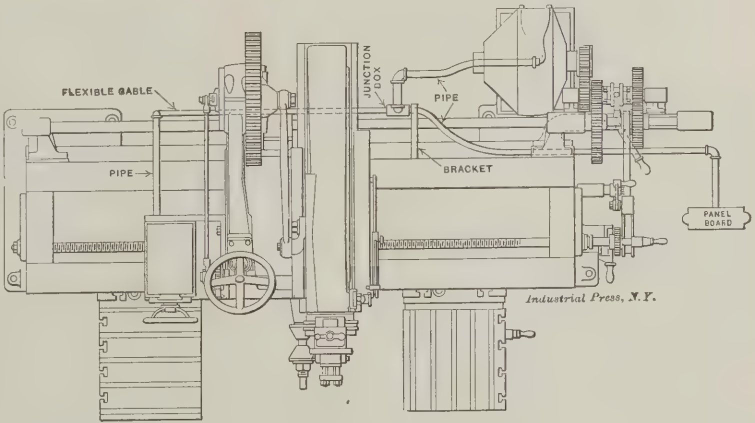


Fig. 1. Electrically-driven Traverse Shaper.



Industrial Press, N.Y.

Fig. 2. Electric Connections from Motor to Controller on Saddle.

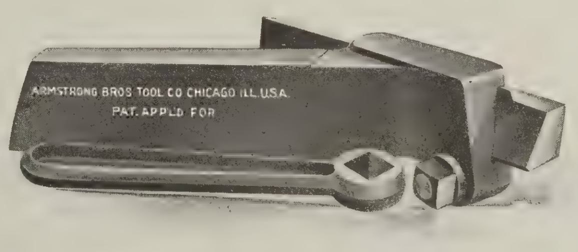


Fig. 1. Offset Side Tool.

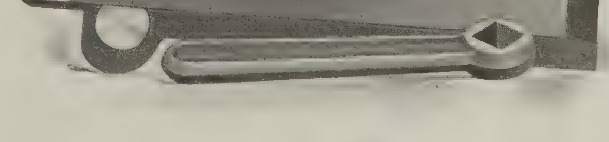
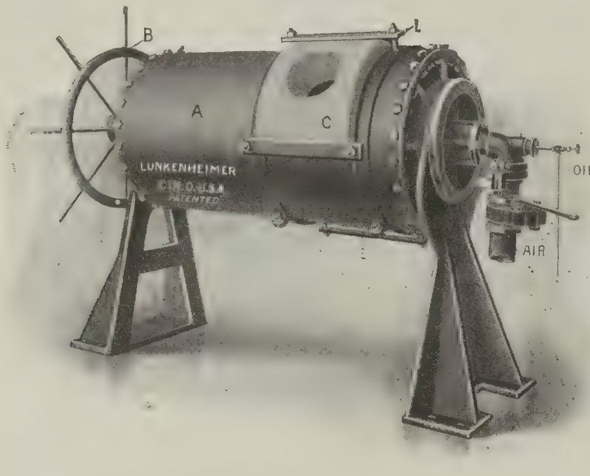


Fig. 2. Straight Side Tool.

LUNKENHEIMER MELTING FURNACE.

The Lunkenheimer Company, Cincinnati, O., have sent us the description herewith of a new melting furnace for the efficient and economical melting of metals, especially brasses and bronzes. It is of the oil-burning type and was evolved after considerable experimenting with different types of furnaces. It consists of a cylindrical sheet-steel drum, *A*, having cast-iron heads, and whose interior is lined with fireproof tile. There are two openings on opposite sides of the drum, only one of which is in use, the other being closed by a fire-clay filling. As a furnace wears out quicker around the filling hole than elsewhere, when one filling hole is worn out it can be closed and the other put in service. Owing to the simple form of tile, it is easy to replace the lining when worn.

The life of the linings is from 300 to 400 heats, according to the metal melted. The company have ten of these furnaces in use, and secure from six to seven heats per day of ten hours, from each furnace. The weight of each heat averages about 550 pounds, and the oil consumption varies from 2 to 2½ gallons of crude oil per 100 pounds of metal melted.

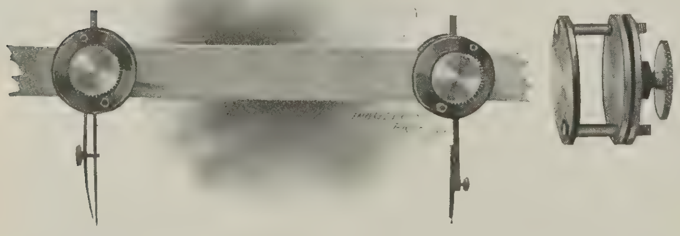


Lunkenheimer Melting Furnace.

The furnace is substantial and durable. It is made in two sizes: No. 1, having a capacity of 550 pounds of metal per heat, and No. 2 a capacity of 1,200 pounds of metal per heat. With the order of each customer within the radius of 1,000 miles of Cincinnati the company will send an expert to start the furnace and take off the first heat, and also instruct the furnace employees how to secure the best results in handling, etc.

COOLIDGE BEAM COMPASS.

Beam compasses of the usual construction are a luxury that many draftsmen do not possess, although a beam compass is an instrument of the greatest utility, even for some work that can be done with the ordinary compasses. Mr. C. E. Coolidge, of Ithaca, N. Y., has attempted to supply a "long-felt want" for something that will take the place of the ordinary beam compass, by making use of the case instruments and a wooden beam. The device is simple, efficient and cheap. It holds anything that can be placed between the clamping washer and beam, including tubular and angular pieces, with perfect rigidity. The flat surfaces are buffed smooth and all surfaces are nickel plated. They are manufactured by Mr. A. W. Stephens, Ithaca, N. Y.



Coolidge Beam Compass.

* * *

The total weight of rivets used in the United States cruiser *Brooklyn* is said by Naval Constructor J. H. Linnard to exceed 330,000 pounds, or 165 tons. Of this weight one-quarter to one-third is in the rivet heads and points.

FRESH FROM THE PRESS.

PRACTICAL LESSONS IN ELECTRICITY. 300 pages, 7 x 10 inches, and over 100 cuts and diagrams. Published by the American School of Correspondence at the Armour Institute of Technology, Chicago, Ill. Present price 90 cents.

The first edition of this work, which was published to call general attention to the scientific yet simple manner in which the American School of Correspondence papers are prepared, was placed on sale at 70 cents per copy. It is needless to say that this low price barely covered the cost of the paper and binding. In about two weeks the first edition was completely exhausted and a new edition has been issued containing 50 additional pages, making 300 pages in all. The price has been slightly increased, to the figure given above.

The book is compiled from four representative text-books of the school's electrical engineering correspondence course. The chapter on storage batteries was taken from the text-book prepared for the course by Prof. F. B. Crocker, of Columbia University; the chapter on electric wiring from the text-book prepared by Mr. H. C. Cushing, Jr., author of "Standard Wiring;" the chapter on electric current from the text-book by Mr. L. K. Sager; also the chapter on elements of electricity. A list of examination questions is given to afford the reader a means of testing his own knowledge of the subjects treated. In view of the great need for a better understanding of the elementary laws of electricity and the construction of electrical apparatus by machinists and others it would seem that this very cheap and good book should meet with a large sale.

AMERICAN COMPOUND LOCOMOTIVES: A Practical Explanation of the Construction, Operation and Care of the Compound Locomotives in use on American Railroads. By Fred H. Colvin. 142 pages, 5½ x 8 inches, and 42 cuts. Published by the Derry-Collard Company, 256 Broadway, New York. Price $1.50.

The author of this interesting and practical work for railway men was formerly associate editor of *Locomotive Engineering*, and is specially informed on the subject, having made it one of special study for several years. The introductory chapter gives a brief historical account of the compound locomotive in America, with brief reference to the Mallet, Von Borries, Worsdell, Webb and Lindner compounds in Europe. A chapter is given to the theory of compounding steam cylinders, following which comes the descriptions of the principal two-, four- and tandem-cylinder compounds that have been built and placed in operation in America. These in order given, are: Baldwin two-cylinder, Pittsburg two-cylinder, Rhode Island two-cylinder, Richmond two-cylinder, Rogers two-cylinder, Schenectady two-cylinder, Baldwin-Vauclain four-cylinder, Baldwin tandem, Colvin-Wightman tandem, Schenectady tandem, and Baldwin balanced four-cylinder compound locomotive of the De Glenn type. A chapter reviews some of the ingenious plans that have been proposed for balancing locomotives, and then follow chapters on locating blows; on breakdowns; reducing valves; drifting; valve motion; disconnecting, etc.

MACHINE DESIGN, PART II: FORM, STRENGTH AND PROPORTION OF PARTS. By Forrest R. Jones, Professor of Machine Design, Sibley College, Cornell University. 8vo, ix + 426 pages and 243 cuts. Published by John Wiley & Sons, New York. Price, $3.00.

The first edition of Part II of Professor Jones' book on machine design was published in the spring of 1899, and its general excellence was at once recognized. Since then we are pleased to note that it has passed through two editions, the copy before us being one of the third edition. About 80 pages of new matter have been added and over 60 new cuts. The new matter relates principally to ball bearings and belts and ropes for power transmission, the available data on both subjects having been considerably extended during the past few years. The chapter on ball and roller bearings has about 32 pages and 23 cuts, of which a considerable part is devoted to the theory of ball action in races of various shape. The new chapter on belt-drives is particularly valuable. It contains three double-page engravings for the graphic solution of belt-drive problems, and numerous other cuts showing three-pulley drives, etc. Readers of MACHINERY will recognize that much of this chapter is a digest of the articles by the same author which appeared in this journal in 1901. The author has been afforded opportunities for examining numerous belt-drives in mills and factories in New England States which are designed and installed on correct principles. Many are for shafts at right angles under conditions that are more or less complicated. We have often recommended this work to students and others, and, of course, the new edition is of still greater value.

WAIT'S CALENDAR OF INVENTION AND DISCOVERY, by John Cassan Wait. Published by the McGraw Pub. Co., New York. Price, $1.00.

This calendar is issued in book form and is unique among calendars and unique among books. Each day in the year contains the names of two men who either were born, or died on a day of which it is the anniversary, and the men selected for this honor are those who have been more or less noted as inventors, discoverers, scientists or engineers. There is a brief statement of their achievements, also. In addition to this biographical summary, the author has selected a large number of quotations, including poetry and prose, from the great writers of all ages, and one or more selections are published for each day of the year. For every printed page of the calendar there is a blank page for memoranda, and altogether it is a useful and interesting production. The question arises, however: Were the great inventors and discoverers obliging enough to have their dates of birth and death distributed throughout the year, so that in the selection of only two per day no important ones would be left out? Perhaps under the law of averages it would come so, or nearly so, especially since under the author's arrangement each dignitary has two chances to be booked. This calendar is to be issued annually, and it is intended to supply it to manufacturers who would like to present it to their customers.

THE MECHANICAL ENGINEER'S REFERENCE BOOK, by Henry Harrison Suplee. Published by J. B. Lippincott & Co., Philadelphia. 834 pages. Illustrated. Price, $5.00; with thumb index, $5.50.

This is the third American mechanical engineers' handbook to be offered to the public, and is to be recommended as a convenient and undoubtedly a thoroughly reliable engineers' reference book, as far as it goes. The adverse criticism which we have to make is that it does not cover the ground of mechanical engineering with sufficient completeness so that a person with this one book at hand can depend upon finding something upon the important problems which arise in practice. While there are sufficient data in many instances, in others the information is noticeably incomplete, or even entirely lacking. It is to be said, however, that so much painstaking labor is required in the preparation of a work of this character that it is an extremely difficult matter to produce a handbook which at the outset can be classed as complete. Typographically, the book is the handsomest of any of the pocketbooks. The tables are unusually clear and the illustrations are well executed, while the binding, paper and press work are all that could be desired. The book is strongest in its treatment of mathematics which, with mechanics, takes up some 300 pages. Its next strongest feature is that of machine design, there being many details and proportions of parts of machines similar to the information given in the best books upon machine design. These machine details are a new feature for an American handbook and will be appreciated by draftsmen. Of the many other mechanical engineering subjects treated the information is concisely and sys-

MACHINERY.

March, 1904.

HYDRAULIC-FEED FOURTEEN-INCH BORING LATHE.

THE powerful machine illustrated in Figs. 1 and 2 is a hydraulic feed 14-inch boring lathe recently built by the Niles-Bement-Pond Co. at the Niles Tool Works, Hamilton, O. It was constructed for the Midvale Steel Co., Nicetown, Pa., for boring forgings, marine propeller shafts, ingots and all other large work from which the core must be removed. This great lathe will take in a shaft having a maximum diameter of 30 inches and a length of 60 feet, and will bore a hole from the solid 12 inches in diameter the full length, or 14 inches diameter for short lengths. It attacks the work from both ends simultaneously and the maximum feed is ⅛ inch per revolution.

Obviously, two boring-bars are used, one at each end, while the work is being held in a hollow spindle or revolving chuck. Two revolving ring steady-rests on each side of the center chuck support the work. The feed pressure required to do such extremely heavy work is so great that it becomes impracticable to feed by rack and pinion or screw. For this reason the boring bars are fed in by hydraulic pressure. The boring bar itself is clamped in a head by means of hydraulic pressure, operating through a lever and toggle joint, which grips it with a pressure of 1,000,000 pounds. The hydraulic pressure against the piston is 720 pounds per square inch, giving the boring-bar cutter head a total pressure of 200,000 pounds against the work.

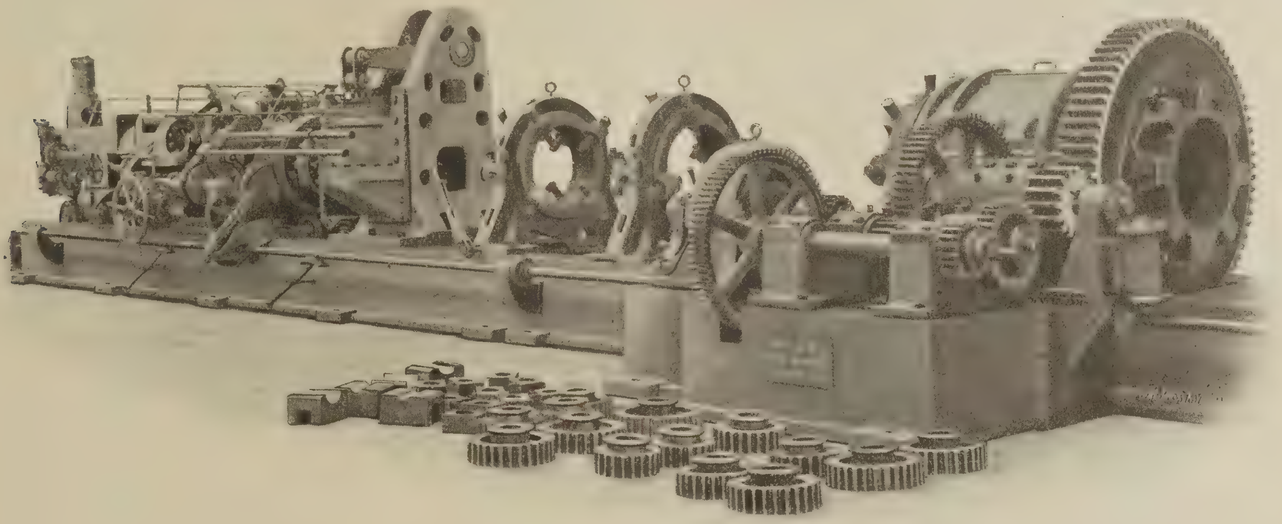


Fig. 1. Chuck and Driving Gear of Hydraulic Feed Boring Lathe, built by the Niles Tool Works for the Midvale Steel Co. Bores a 14-inch Hole from the Solid in Short Lengths and a 12-inch Hole from the Solid in 60-foot Lengths.

It is obvious that an arrangement like this, if using the unrestrained hydraulic pressure, would allow the tool to gouge into the work should the metal be soft, and, generally speaking, would not offer any means of control of the feed. In order to provide for this control the rear end of the piston, that is, the end projecting backward from the cylinder, is cut as a very steep sextuple screw, the lead being 18 inches. A bronze nut revolving on this screw has a worm-wheel with very steep pitch cut on its outer circumference. The angles of the screw and the worm are so chosen that the pressure against the piston will be able to revolve the nut, and the movement of the nut will be able to revolve the worm, but a relatively small amount of resistance on the worm will entirely check this movement. This amount of resistance is provided by ordinary feed mechanism taken from friction disks, which have the necessary change-gears, etc., to enable the operator to get any feed desired. It will be seen, therefore, that the hydraulic cylinder furnishes the pressure and the feed mechanism is never subjected to the heavy strains due to the exceedingly heavy work to be done on this machine.

Fig. 1 clearly shows the driving power of this machine. It is driven by a 100-horsepower Westinghouse motor, 220 volts. A motor of this make and size always allows of some speed variation by means of field control. The range of speed is increased by the change-gears, which are also shown in the illustration.

The main driving gear, which is bolted onto the hollow spindle or chuck, has 75 teeth, 4 inches pitch, 10 inches face. It is a steel casting, as is also the spindle. The hole in the spindle is 31 inches diameter. The piece to be bored is chucked by means of eight huge set-screws 3½ inches in diameter, on each side of the hollow spindle.

The feed is taken from the last driving-shaft, and is transmitted to the two cylinders by means of the long shaft running alongside and in front of the bed. This shaft is supported by drop-bearings and is made in three pieces coupled together. Change-gears and friction disks give a wide range of feeds. A hand feed is provided for by means of hand-wheel. Before using this hand-wheel, the friction disks and feed driving-shaft are disconnected by means of another hand-wheel. A 5-horsepower motor gives a fast motion to a train of gearing, whereas the feed mechanism gives a slow motion to the train.

A clutch-lever throws in either one or the other, and thus gives either a slow feed or a quick traverse of 10 feet per minute to the piston if the cylinder is clamped to the bed, and to the clamping head; or if the clamping head is clamped to the bed it gives this quick traverse to the cylinder. This quick traverse is really gotten by means of hydraulic pressure in the cylinder, and the small motor only regulates the speed. A hand-wheel gives adjustment to the piston and clamping-head, or to the cylinder should this latter be clamped to the bed.

The parts to be moved being very heavy, it is natural that a great amount of movement of the hand-wheel is required in order to produce a small amount of motion of either the clamping-head or cylinder, and consequently, if the cylinder is traveling at a rate of 10 feet a minute, by power, this hand-wheel would race at a terrific speed, which would be dangerous to the operator. For this reason the arrangement of the hand-wheel is made in such a way that the hand-wheel is loose on its shaft or stud if either the quick traverse or feed is thrown in, and is only connected to the mechanism which moves the cylinder when both feed and quick traverse are out of action, thus avoiding all possibilities of danger.

The train of gearing moved by the motor can be connected to the cylinder mechanism, or it can be connected to the shaft,

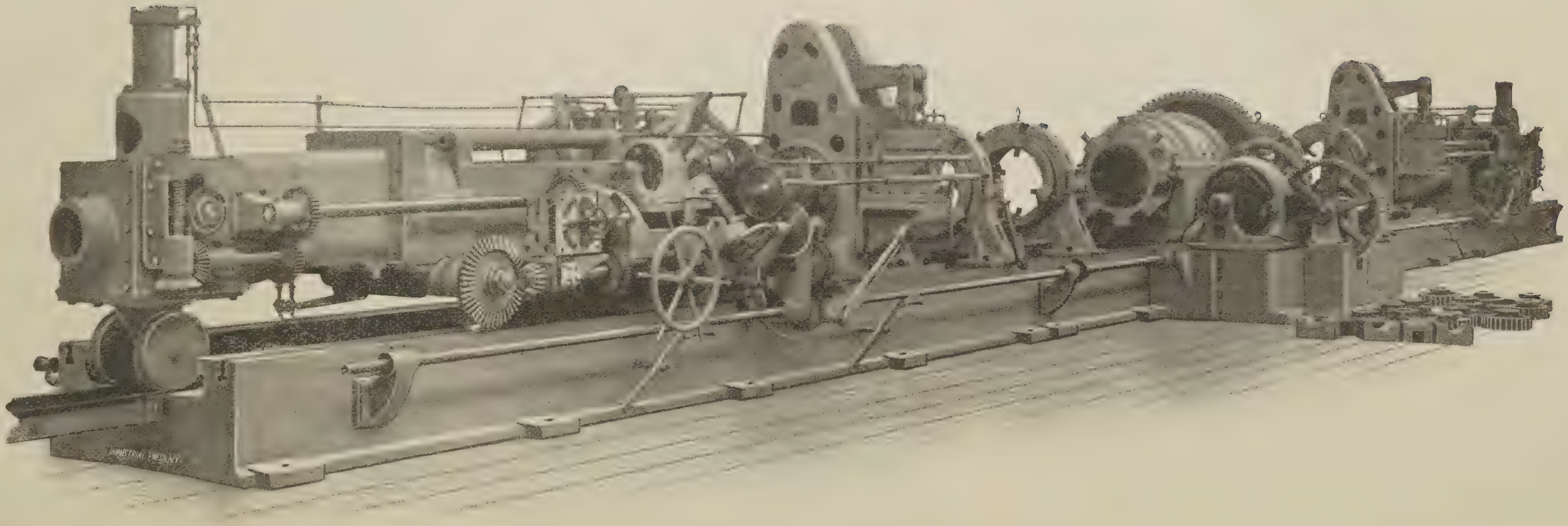


Fig. 2. Hydraulic Feed Boring Lathe. Length of Bed, 130 feet; total length of Machine with Boring Bars extended, 220 feet.

which, by means of suitable gearing, drives a grooved roll, not visible in the illustration, but which is held in a floating frame inside of the rear part of the cylinder casting. This floating frame carries the hydraulic cylinder, the piston of which is connected to the grooved roll while the cylinder casting is connected to the two other rollers under the bar. By admitting water in this cylinder the inner boring-bar is clamped between the rollers, and by moving the grooved roll a quick traverse motion is imparted to the inner bar.

The mode of operating the machine is to force 4 feet of the boring-bar into the work. By that time the clamping-head is up to the work and 4 feet distant from the cylinder. The quick traverse is then brought into play and the clamping-head is pulled back until it comes up to the cylinder. The inner boring-bar is then pushed 4 feet further forward and the boring-bar is once more forced into the work another 4 feet. This alternate action of forcing the bar into the work and drawing the clamping-head back so as to take a new grip is repeated until the center of the work is reached. Before setting up new work, whereby, of course, the position of the clamping-head and cylinder may have to be relocated, the following mode of operation is adopted:

Supposing the cylinder and clamping-head are near the center of machine and are wanted at the extreme end of the machine, then the clamping-head is first clamped to the bed and, by means of the quick traverse, the cylinder is pushed back 4 feet; the cylinder is then clamped to the bed, the clamping-head loosened and run back 4 feet. This cycle of operations is repeated as many times as necessary. The inner boring-bar can, of course, be withdrawn in one operation.

The piping for the different cylinders is at the rear of the machine supported in brackets or rollers where the piping slides. There are handles for operating the various valves both on the front and rear sides of the machine. The weight of the boring lathe without the boring-bar, is 360,000 pounds and its length is 130 feet. With the boring-bars extended as they are when starting to bore a 60-foot shaft the total length is 220 feet.

* * *

A novel plan for strengthening the Brooklyn Bridge so that it can safely carry greater traffic is proposed by Bridge-Commissioner Lindenthal. The present structure has a capacity of two railway tracks, two trolley tracks and two narrow roadways less than nine feet wide and a promenade for foot passengers. The present width of the structure is 86 feet; the width of the reconstructed bridge will be 105½ feet. The live load for which the bridge was originally designed is 2,000 pounds per lineal foot; the capacity of the reconstructed bridge is to be 11,000 pounds per lineal foot. It is to have accommodation on the upper deck for four railway tracks, and on the lower decks for two trolley tracks. There will be two roadways 17 feet wide each, and the footpaths will be at the sides, each 8½ feet wide. Briefly the proposed plan requires no additional cables and no additional load will be imposed on the tops of the stone towers. Stiffening frames are to be built in harmony with the present structure to carry the dead load of the roadway and the cables will only have to take care of the live load. These stiffening frames will be given fixed pier bending moments by means of hydraulic cylinders between the ends of the bottom chords where they will be in compression. The pressure on the pistons will be maintained constant so that the stiffening frames will always sustain a definite dead weight load.

* * *

A correspondent in a contemporary describes a method of making "inexpensive twist drills," it being substantially that employed by blacksmiths in making twist drills of the auger type. As a matter of fact, such drills will invariably be found the most expensive kind that can be used, when their weakness and inefficiency are considered, and it is not likely that any up-to-date shop superintendent would countenance the making and use of such drills unless it was for some job requiring special tools.

INJECTOR TROUBLES AND REPAIRS.

WITH SPECIAL REFERENCE TO LOCOMOTIVE INJECTORS.

FRED H. COLVIN.

Fred H. Colvin.

Injector repairs are more or less of a problem at best, and do not seem to be well understood in too many cases. To begin with, the engineer should report in detail just how a faulty injector works or fails to work. These symptoms vary widely and if carefully reported give a clue to the disease. It is very little assistance to be told "injector won't work," as this may mean one of a dozen things.

Remember that the maker ought to come pretty near knowing what is right in the way of tubes, and that it is a good plan to keep a set of new ones on hand just to measure from, if you have to clean scale out of the tubes, or to make new ones. On general principles it does not pay to make these; it is cheaper in the long run to buy them of the maker and keep them in stock for repair work. Of course the price seems high at times and we know the maker has his profit, but he knows how they should be made and has the tools for doing it. You can easily get the sizes from one set you buy, but it is not easy or cheap to make the proper tools for duplicating them. The sizes and the tapers have been determined by experience and are probably about right. Do not think that somewhere near this size will do just as well. It will not, and this is especially true of diameters of holes.

It is sometimes possible to clean out old tubes that have been scaled or pitted, if this can be done without materially changing the ratio of areas; but it is generally cheaper to put in a new set when they reach this condition. This may appear expensive but we must not forget that the injector is a very important apparatus. For unless the boiler gets its regular supply of water it is a case of drawing the fire, laying out the train and perhaps blocking the road, which would cost more than all the new sets of tubes needed for ten years on that engine.

It is pretty safe to assume that the injector is all right and that the trouble is with the piping or somewhere outside the injector proper. This is not always true, for tubes will wear out, especially if the water is bad or sandy; or they will fill up if the water is full of lime. In the latter case they can be cleaned out with tools or the scale dissolved in a bath of one part muriatic acid to ten parts of water. The safest plan is to have a testing plant where the injector can be taken right down and coupled up where it is certain the conditions are right. Then, if it does not work the injector itself must be examined. If it does work, as it probably will, you know the trouble is somewhere else.

A very convenient testing plant, and one that does not cost much to erect, is shown in Fig. 1. It can be readily adjusted for any size injector and is handy to operate. The writer has tested several thousand injectors in this way and knows that the plan is thoroughly practical. The sketch shows the essentials but does not show the beginning or ending of the pipes, as this will depend on the surroundings at each place. The water supply should be connected to a tank a little higher than the injector. An old cask, if it is large enough, will do nicely. This can be supplied from the city main, and it acts as an equalizer of pressure, so that injector gets the same water pressure at all times. Of course nearly all locomotive injectors are of the lifting type and do not require water to flow to them; but it is well to have this provision in all cases, as it enables one to test non-lifting injectors if one has to, and it is also handy to have with "lifters" at times.

With this the water can be made to flow to a lifting injector which has refused to work on the locomotive. If it works here with water flowing to it, one can feel pretty sure that the trouble lies in the lifting portion of the injector. By shutting off the water supply by a suitable valve and opening suction in the tank one can test the lifter. If it lifts but will not force water into the boiler then the trouble is evidently in the forcing tubes. We will refer to these symptoms in order later.

Steam comes in at the top, water comes up from the bottom and discharge goes out at the end marked. Each pipe which must be moved to suit different styles or sizes of injectors should have an expansion joint, as shown at *X X*. These are simply inner and outer sleeves, with the outer one carrying packing, as shown. Each expansion joint should have a locking rod, as indicated, to prevent forcing apart when pressure is on. A piece of ½-inch iron rod, bent to go around or over pipe and clamped as shown, answers very well and is cheap. In some cases it is also advisable to put in the expansion joint in the upright water pipe, but as a rule connections can be made of the right size for this.

Make the apparatus of the largest size pipe needed for your work—say, 2-inch pipes. Put the proper couplings in place at the end of the pipe by using a union on the end of the pipe and screwing the swivel and nut into this, as shown. For all smaller sizes simply make reducers, as shown at *a* and *b*. These are brass plugs which fit the large injector coupling nuts on pipes, threaded for the smaller sized swivels, as shown. These swivels can be made of just the right length to fit without expansion joints, if desired, but where a variety of injectors are tested the plugs will be found useful. Clamp *d* shows how the locking rods are held in position. Fitting *c* shows a connection for a type of injector where the steam connection is at the end instead of at the top. It fits into steam pipe and the injector coupling nut is on the angle valve.

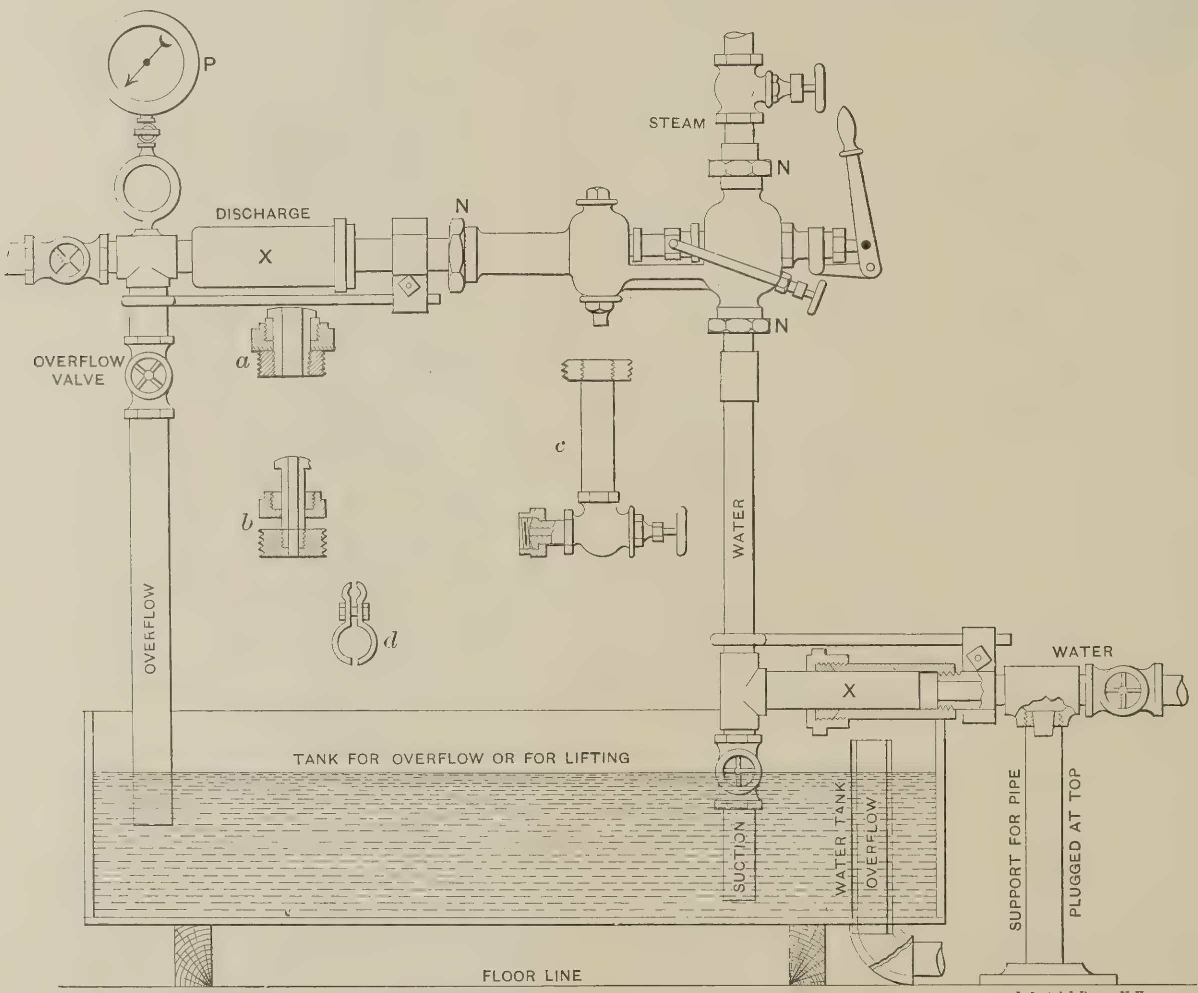
Right here let me say that in the testing plant, as elsewhere, put on valves so that the pressure tends to open the valve. You can pack the valve easily and you can start the injector much more steadily. With pressure the other way there are sure to be times when the disk will bother by "taking up the slack" at the wrong time.

The discharge is an open question. If you can use it for washing out boilers or similar work, pipe it up to wherever you want. Unless you have use for it there is no need to pipe it anywhere but to the tank shown under the pipes. Have this run down fairly well in the tank to avoid splashing. This overflow should have a valve or stop-cock; so should the suction shown under the water pipe and used for lifting water from the tank. In the discharge somewhere put a pressure gage, *P*, and have a steam gage on the steam end to show the pressure you are getting, which should be about the same as is being used by the locomotives in order to tell just what you are doing—as injectors behave very differently at different pressures.

Now we will suppose an engine comes in with a balky injector. Take it off and put on a spare one, so that engine can go out at once if necessary. Take the cripple to the testing plant and couple it up. Close overflow and all valves except the steam, and put on full pressure and let it stay for a minute. This will show up any leaks in the body or in joints. Now shut off steam, open overflow, and run the water through, to cool off the injector. Open the valve in the overflow pipe and with the water flowing from the tank, open the steam valve and start the injector. If it starts, let it run and gradually close the valve in the overflow pipe. This will direct a pressure on the gage *P* which will show the pressure of water discharged. This should exceed boiler pressure about 20 per cent. to be safe in actual work, *i. e.*, a steam pressure of 100 pounds should be able to force against a pressure of 120 pounds on the gage *P*. The overflow valve should not be entirely closed, however, or the injector will "break," owing to the steam boiling the water in the tubes on account of having no place to force it. If the injector will not show the desired pressure on the gage, or if it breaks before reaching the pressure of the boiler, you can count on the tubes being worn out of proportion. And if you compare them with your standard set of tubes you will probably find the discharge tube worn large in proportion to the steam tube. Or it may be that the mouth of the combining tube is cut out of shape.

If it works all right, you will expect to find the trouble in the lifting apparatus if anywhere. To ascertain this shut off the water supply, open the valve in the suction and try the lifter. In many cases this simply means the first pull of the injector lever. If it lifts all right and starts to work, you know the trouble is in the pipes or tank and not in the injector, and that the new one you put on will probably do no better than the one taken off. For this reason it is a good plan to test the injector at once and so find out whether to look for trouble in the pipes or not. Or if you try the new one after putting it on you are also informed in this respect.

This testing rig can be modified, elaborated or simplified to suit requirements. If you have only one style of injector some of the adjustable features can be omitted. If you wish to test temperature of feed water and discharge, connect the thermometers with the water and discharge pipes as near to injector as possible. This will enable you to see the temperature of feed water, whether it is lifted or comes from the tank. If you want to test the lifting capacity, couple a vacuum gage on the suction so it can be connected in at any time. A regular gage or a mercury column can be used, but either should be graduated to read in feet. To test the capacity—have both tanks measured so that whether taking water from above or lifting it, you can note the time taken to empty the tank. If you are lifting water it will, of course, be necessary to have a separate discharge for the water so that it will not go back into the tank. In this connection it may be interesting to calculate the velocity of the water. Let us suppose that a No. 10 injector has a discharge tube with an opening 4-10 of an inch in diameter, which gives an area of ⅛ of a square inch. Suppose we find it throws 3,000 gallons an hour or 50 gallons a minute. Reduce this to cubic inches by multiplying by 231 (the number in one gallon), and we find it to be 13,550 cubic inches, which must pass through ⅛ of a square inch in one minute. Dividing 13,550 by ⅛, which is really multiplying it by 8, we get 108,400 inches per minute, or (dividing by 12) 9,033 feet per minute. While this is a supposititious case it is not very far out for some cases, and when we consider that it means over 100 miles an hour, we realize that it is traveling rather lively.



Industrial Press, N.Y.

Apparatus for Testing Injectors.

With no intention of going into the theory of injectors it will be well to study the conditions necessary for them to work. Steam flows through the steam tube and mingles with the water in the mouth of the combining, or concentrating tube, as we may call it. The water condenses the steam which, of course, becomes water, and mingles with the feed. The incoming steam forces this through the tubes and more steam and water come in to take their place. As long as they are in the right proportion, the process is continuous and the injector "works"; change this proportion beyond the working limit and it "breaks" or "flies off."

The proper mingling depends on the amount of water, the amount of steam and the volume contained in the mouth of the combining tube, as well as on its distance from the steam tube. Then, too, experience shows that certain shapes are best adapted for the easy flow of the water, and these are used by the makers. Formerly the tubes of some makers were reamed with a curve taper, but straight-sided reamers are now used, as it has been found that they are practically as good and much cheaper.

All the steam admitted must be condensed or it will boil the water in the mixing chamber or blowback, causing it to break. If we use just as little water as possible and condense the steam, the water that goes to the boiler will be hotter than if we used all the water the steam would take up. So if for any reason you require hotter feed, "starve" the water supply all you can and still have injector work. This is practically what is done when the injector is run at its smallest capacity, and is one advantage of continuous feeding of the boiler rather than intermittent doses of cooler water. The efficiency of the injector, however, from the standpoint of greatest amount of water thrown per pound of steam is much reduced. If we "starve" it too much, steam will not all be condensed, but will show at overflow and injector will break. If, on the other hand, there is too much water, the steam cannot force it all into boiler and the surplus will go out of the overflow, which somewhat cools the water delivered and also wastes the water. These few facts give us clues for analyzing symptoms and knowing where to look for trouble.

One of the simplest injector tests is to just look through the injector; very frequently a small piece of coal or wood lodges in the tubes and makes trouble. A few injectors have an internal check valve. This prevents looking through them but it will often be found profitable to take this out so as to have a look.

With the testing plant in good shape we know that there is no trouble with the pipes. If an injector starts and then breaks it is because conditions have changed. The only changes could be the heating up of the body; or water if used as a lifter, or the accumulated pressure in discharge being too much to force against it. If this is the trouble the overflow is not opened enough or the injector has not enough force or power. This would indicate that the discharge tube was worn too large. If it comes from the heat, the injector is too sensitive and probably the steam tube is too large or the water passage is contracted.

If it wastes water at the overflow there is more water than the steam can handle or perhaps the tubes are not in line so that part of the water splashes out between the combining and discharge tubes, where these are separate.

Where it blows steam and then breaks, this indicates that there is not water enough to condense the steam. With the injector coupled on engine this is usually a signal to inspect the hose strainer, or the tank strainer, or both. If it starts all right and sputters and coughs, the symptoms indicate air in the suction. If there is much air it will break altogether. This is also sometimes an indication of an intermittent water supply caused by a piece of wood floating against strainer in tank, or waste temporarily clogging it. In stationary work this is sometimes caused by the injector being connected to the same source of supply as a pump. When the pump draws in a cylinderful the injector suffers and sometimes breaks. A case of this kind was very puzzling to the writer on one occasion, where the connection was not visible. An injector should always have a separate supply of both water and steam. The steam should be as dry as possible, as wet steam will not condense as readily in the combining tube and helps heat the water to the boiling point.

High-pressure steam requires more water or colder water to condense it, so that the steam tube can be smaller in proportion to the water supply. Some makers supply tubes for both high and low pressure. The difference is in the steam tube, which is smaller in the case of the high-pressure tubes. Low-pressure steam delivers much more water per pound of steam than high pressure. According to Kneass, the best authority on injector design and work, there should be about 29 pounds of water per pound of steam at 10 pounds gage pressure of steam, 16.6 pounds at 110 pounds gage pressure, and 8.8 pounds at 200 pounds of steam.

The heat of feedwater also affects both the lifting and forcing capacity of an injector. The distance an injector lifts its water also has a great effect on its capacity, simply because there is more work for the steam to do. With an injector which, at a lift of one foot, handled 14.5 pounds of water per pound of steam, this was reduced to 11 pounds at 10-foot lift, and less than 7 pounds at a 20-foot lift.

Here, as elsewhere in mechanics, it is simply a question of work done and energy expended. The injector combines mechanical work and transfer of heat. Whatever is lost mechanically is given up as heat to the water, the only real loss being the radiation from pipes and the injector itself.

Leaky check valves cause a lot of trouble in the injector line. They allow steam and hot water to flow back into the injector and make it difficult to start.

A little study of the proper conditions under which an injector should work will make it comparatively easy to guess somewhere near the cause of trouble. There's no mystery about it. If conditions are right it will work every time. A little judgment will soon show where to look for the trouble. Some makes are more delicate than others, and some parts wear or get out of adjustment very quickly. The repair man soon gets to know these parts. But in most cases you can count on the trouble being outside the injector itself. The feed pipe is especially apt to give trouble.

After an injector has been repaired or cleaned it should be given a thorough test, just as is given an air pump, and then you are sure that it is ready to be used in an emergency.

* * *

ENERGY OF WIND AND TIDES.

That large amounts of energy produced from natural sources are continually running to waste is, of course, well known to every engineer, but members of the general public as a rule entertain exaggerated and erroneous views of the commercial possibilities which such sources contain. Untrained imagination plays a large part in their estimation of physical phenomena, and prompts occasionally amusing suggestions in the way of power development schemes for professional friends. A large river moving steadily but slowly under an insignificant head impresses the general observer with a sense of majesty and power that is altogether out of proportion to the energy available, and it is not easy to convince him that an attempt at realization would be a commercial failure, and that for practical purposes it is not to be compared with the thin stream that comes down a hill in a 6-inch pipe under a head of 100 feet and operates a turbine at its base. The potential energy of such a pressure does not impress him. Actual kinetic energy is the only kind he understands. Hence he so often asks, "Why don't engineers use the energy of the tides for useful purposes?" and "Why do they not bridle the thundering waves?" only he recognizes that, like the wind, they are fickle. It is this uncertainty of action that to him alone accounts for the general absence of windmills, which are in his imagination giant sources of power, but, unfortunately, cannot be always depended upon, and hence are comparatively useless. His conceptions, however, of the real power capacities of these motors is lamentably weak, and he listens with a smile of incredulity to the statement that a 10-mile-an-hour breeze and a 25-foot wheel would probably not generate more than one horse power. He is equally surprised to learn that the positions where the necessary reservoir accommodation could be constructed so as to utilize the energy of the tides for power purposes on anything like a practical scale are exceedingly few, and even then, with the most favorable arrangement for securing continuous output and two storage reservoirs, only about two-thirds of the rise of the tide could be utilized, so that a tidal range of 10 feet would require about one-third of an acre of reservoir area for each horsepower produced. It requires, indeed, very little close reasoning to arrive at the conclusion that the places where the rise and fall of the tide can be used for power producing purposes are few and far between. They do not afford any temptation to resort to this method of producing useful work with advantage, and are likely to remain so as long as coal or other fuels can be obtained at present prices and converted into useful work by existing heat motors, inefficient though the process of conversion may in some senses apparently seem.—*Mechanical Engineer.*

* * *

The United States Consul at Pretoria, South Africa makes a report regarding American-built steam boilers that is scarcely flattering, to say the least. A firm imported an American steam plow at heavy expense and found after it had been examined by the official inspector of machinery that they would be unable to make any practicable use of the machine, simply because the inspector would not allow the rated pressure—140 pounds per square inch—to be carried. On account of the faulty construction 110 pounds was the maximum limit. Just previous to this incident it appears that nine new American boilers were rejected at Johannesburg as absolutely worthless. In the light of these facts it would appear that some of our boilermakers who are looking for foreign trade should bestir themselves and find what requirements must be complied with in boiler building for that trade. Not all governments are as indulgent in this matter as Uncle Sam.

TOOL MAKING.—4.

COUNTERBORES.

E. R. MARKHAM.

Counterbores are used for enlarging a hole without altering its location, and are made with a body part provided with cutting teeth, and a pilot. The pilot must be the same size as the hole to be enlarged, while the body must be of a size that will enlarge the hole the desired amount.

For making a counterbore for a few holes, or when it is necessary to make one as quickly and cheaply as possible, there is what is known as a flat counterbore, shown in Fig. 1. This can be so made as to require very little work in the machine shop, provided the forging is done carefully. After centering and squaring the ends the portions marked *A*, *B* and *C* are turned to a size a few thousandths of an inch larger than finish; then the necked portions between the pilot *B* and the body *C* are made and the faces of the lips *D* squared. After this the portions *A* and *B* are finished to size with a file. The flat sides of the body *C* may be filed smooth, if there is but little stock to be removed; but if there is too much stock to file they may be milled with a shank mill such as shown in Fig. 2, the counterbore being held between the centers of the index head on the milling machine. One side of the body is milled, then the knee of the milling machine is lowered sufficiently to allow the counterbore to be turned one-half revolution so that the other side may be milled.

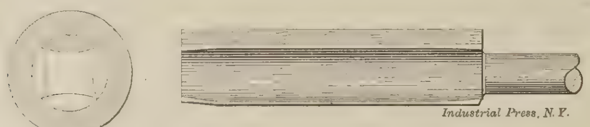

Industrial Press, N.Y.

Fig. 39. Square Reamer.*

The sides *C* must be milled lower than the plane of the pilot in order that it may cut. At times it is considered desirable to mill the pilot on opposite sides to the thickness of the body, and in such cases it is not necessary to lower the knee, because the carriage of the machine may be moved till the work is far enough away from the cutter to eliminate the danger of its hitting when revolving the work.

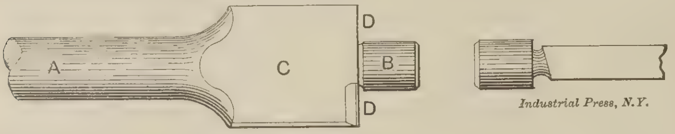


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Fig. 1. Flat Counterbore.

When the knee must be lowered to allow the counterbore to be revolved without touching the cutter, notice the reading of the graduated dial on knee elevating shaft, so that the work may be raised to the same position when milling the opposite side. An excellent way consists in turning the graduated collar to O, when the knee is at the proper height. This will be more easily remembered than 189 or some other number, unless we always turn the collar to that number. But since we are to habituate ourselves to setting to a certain number, why not use the natural one, which is zero?

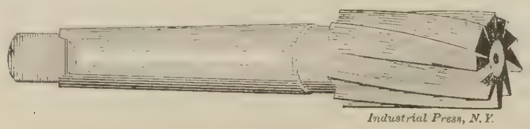
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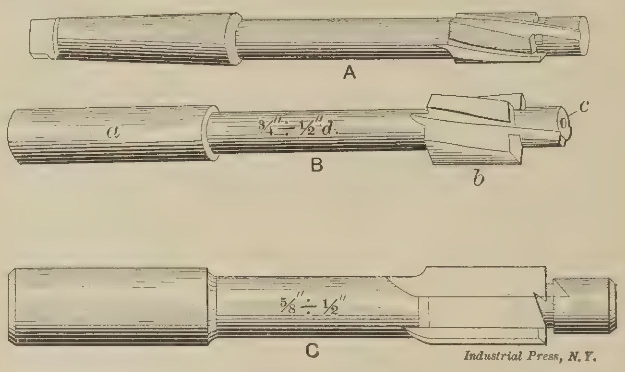
Fig. 2. Shank Mill.

The flat sides being finished we next draw-file the edges, removing a greater amount of stock on the back than on the cutting edge. This gives a slight clearance and prevents the tool binding when in use. We now file the cutting edges for clearance, as shown at *D* in Fig. 1, in order that they may cut. When giving clearance to tools of this character extreme care should be observed, for while it is necessary to carry the clearance to the edge, we must not remove any of the edge; for in all probability we would remove more stock from one tooth than another, and then the longer tooth would do all the cutting, and consequently the counterbore could not be made to remove stock as rapidly, neither would it last as long as if the teeth, or cutting edges, were of the same length and each did its proper amount of work.

It will be necessary to harden the pilot and body the entire length, to prevent their roughing up when in use. The amount necessary to draw the temper will depend in a great measure on the work the tool is to do. Ordinarily, however, it may be drawn to a full straw color (460 degrees).

If this counterbore were intended for permanent equipment we should leave it .010 to .015 inch large at *A*, *B* and *C* when turning, so that it may be ground to size after hardening. This is not only necessary in order to get exact sizes, but to insure its being true; for when being hardened it would in all probability spring, and if it did, and there were no way of truing, it would run out of true. However, as this form of counterbore is usually selected on account of its cheapness it is not generally considered necessary to grind it after hardening.



Industrial Press, N.Y.

Fig. 3. Forms of Counterbore.

When counterbores are wanted for permanent equipment it is advisable to make them of the form shown in Fig. 3. In this sketch *A* represents a taper shank counterbore having spiral flutes, *B* a straight shank counterbore with spiral flutes, and *C* a counterbore with straight flutes. The shank may be either straight or taper.

Counterbores for screw holes are generally made in sets. Each set contains three counterbores: One with the body the size of the screw head and the pilot the size of the hole to admit the body of screw; one with body the size of head of screw and the pilot the size of tap drill, and the third with the body the size of body of screw and the pilot the size of tap drill.

When centering stock to be used in making counterbores or similar tools do not use a large centering drill, or countersink very deeply. This would weaken the tool when in use and cause it to crack when hardened. If, however, through carelessness, or ignorance, a counterbore should be made having a center looking like Fig. 4 you can reduce to a minimum the liability of cracking when hardening by filling the hole with fireclay mixed with water to the consistency of dough. This should be allowed to dry before the counterbore is placed in the fire.

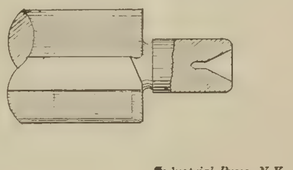

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Fig. 4.

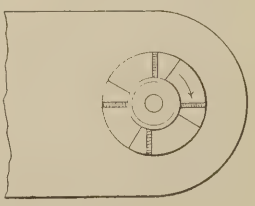

Fig. 5.

After squaring the ends the stock may be rough-turned to a size a little larger than finish—say 1-32 inch. If it is a taper shank counterbore the tenon may be milled or filed to size and the portions *a*, *b* and *c* at *B*, Fig. 3, turned to sizes .010 to .015 inch larger than finish, the portion *d* may be turned to size and stamped with the size of the body and pilot or any distinguishing mark desired. It is advisable when stamping articles of this character to use a V-block as a holder. Sometimes the inexperienced man will lay the tool on a piece of board or on the bench when stamping, and then wonder how it got sprung!

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*This cut refers to the paragraph on square reamers in our last article, and was inadvertently omitted.

The next operation in order is the milling of the grooves that form the cutting edges of the tool. One method consists in cutting the grooves with a right-hand spiral of 10 to 15 degrees. Another method is to cut them straight. When cut with the spiral shown at *A* and *B* in Fig. 3, the chips are run back from the cutting edges and out of the hole, unless it is too deep. This spiral counterbore works nicely on wrought iron and steel, while the counterbore with the straight flute is generally considered more satisfactory on brass and cast-iron, but it also works well on wrought iron and steel.

It is generally thought best to cut the flutes of a counterbore so that the face of the cutting edge will be a trifle ahead of the center, rather than radial. This is especially the case where the counterbore is to be used as a facing tool and it is desirable to produce a smooth surface. For a tooth facing ahead of the center, takes a scraping cut, and the tendency to tear the surface being cut is reduced to the minimum. The grooves in small counterbores are often made with a file, and in such cases it is best to make a spiral groove. A man accustomed to filing of this character can produce a nice cutting tool and at the same time a tool of good appearance by means of a round edge or a round file, and can file one or two small counterbores in less time than it would take for a milling machine to be rigged up and the job milled. However, when they are made for permanent equipment it is often considered desirable to have a uniformity of groove in the various counterbores, in which case it is best to mill them.

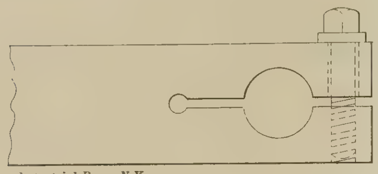
Industrial Press, N.Y.

Fig. 6.

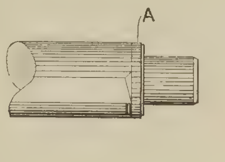

Fig. 7.

For most purposes counterbores are made with four cutting edges; small counterbores are often made with three, but unless the sizes are plainly stamped on them it is difficult to determine their size by measurement. Sometimes, however, small counterbores are given three and sometimes only two cutting edges. While large ones—especially those to be used as facing tools—are given more than four, the exact number cannot be arbitrarily stated; the nature of the work and the conditions under which they are used must determine this.

Generally speaking, the grooves should be cut below the surface of the pilot, as shown in Fig. 3. By so doing we facilitate the operation of backing off the cutting edge for clearance. When cutting the grooves below the plane of the surface of the pilot the stops should be located on the carriage of the milling machine to give the proper length of flute; otherwise the grooves would be of different lengths, and while they might work as nicely as in a counterbore whose grooves were of a uniform length, they would not look well. And it is a fact known to most mechanics that a workman who is careless as regards the appearance of his work is very apt to be careless as to accuracy. It takes no longer to cut flutes of uniform length in tools, and it is advisable for a man to cultivate a taste for appearances that will not allow him to make an unsightly tool if it can be avoided.

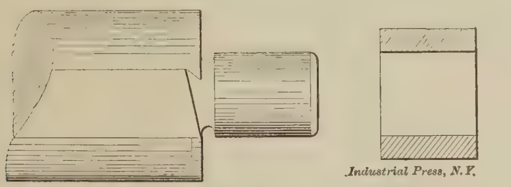
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Fig. 8.

When cutting the flute below the plane of the surface of the pilot, elevate the knee by means of the knee elevating shaft, and after cutting to the proper depth, the carriage is fed along to give the desired length of flute. Having milled one flute to the proper depth notice the reading of the graduated collar on the elevating shaft; or a better plan is to turn the collar until the line marked O will correspond with the line on the knee. Now lower the knee sufficiently to allow the counterbore to be turned to position for the next tooth. If the counterbore is long and slender it is well to support it when cutting the flutes, which may be done by means of the adjustable support furnished with all universal milling machines.

The flutes being cut, the next operation is to file the faces of the cutting edges to smooth them, so they may produce a smoother surface.

In order that the counterbore may cut, it is necessary to back off the cutting edges so it can penetrate the stock. This is usually done by filing, although in shops where counterbores are made in large quantities a machine is used for this purpose, and the backing off is done with a tool. To have this backing off accomplished in a satisfactory manner it is necessary, when turning the counterbore in the lathe, to neck down between the pilot and body, as shown in Fig. 4, which should be done with a tool whose corners are rounded, to prevent a tendency to crack when the counterbore is hardened. The amount of clearance given the cutting edges depends somewhat on the nature of the work to be done, but for general work an angle of 4 or 5 degrees will be found satisfactory.

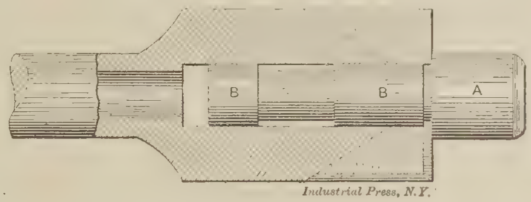

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Fig. 9. Counterbore with Inserted Pilot.

With these counterbores, as with the flat counterbores, it is necessary when filing the cutting edges for clearance to make sure that the filing extends to the cutting edge, and that a keen penetrating edge is produced; but we must not shorten the tooth, as we could not shorten them all alike, and unevenness of length of tooth would result, the tool losing its efficiency thereby. This fact should be borne in mind when backing off any cutting tool having more than one cutting edge, and is especially noticeable in such tools as taps and screw thread dies. After hardening, the temper may be drawn to a light straw color if the tool is strong; if not, it must be drawn lower.

One thing should be remembered: The object attained in drawing temper is to reduce brittleness to a point where the hardened tool will be able to stand up when in service. Now the harder a tool is, the longer it will stand up between grindings, provided it does not crumble or break from brittleness. Temper is drawn to prevent this breaking from brittleness; not that it is desirable to soften the tool, but to remove brittleness we are compelled to soften the tool. Therefore it is apparent that it is advisable to leave tools as hard as possible consistent with strength.

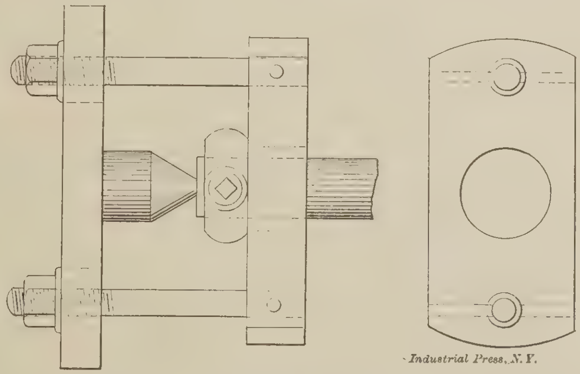
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Fig. 10. Yoke for Fastening Work to Live Center.

In years gone by, when emery wheels were not as common as they are to-day, it was generally considered good practice to draw counterbores and similar cutting tools to a full brown color, or even until purple spots appeared. This was done so as to make it possible to file the cutting edges, to sharpen them when dull. But this is a costly method of procedure and not the best practice where an emery wheel is available. It is mentioned because there are times when even makeshift methods prove valuable.

Counterbores having slender pilots are liable to break, when in use, at the point where the pilot and body join. For this reason some mechanics consider it advisable to draw the temper of the pilot to a blue; but this is not generally considered good practice, as it is not possible to draw it so low at the point where it joins the body (and this is where they break) without drawing the temper of the cutting edges lower than is desirable. And drawing the balance of the pilot so low causes it to rough up when in use, especially if the material being cut is cast iron. So it would appear that this method reduces the efficiency of the tool without making it perceptibly stronger. To get the greatest strength possible the necking between pilot and body should be done with a tool whose corners are somewhat rounded, and when the tool is hardened it should be heated uniformly to a low red, and dipped in a lukewarm bath. High heats, and careless, uneven heating are a source of much trouble when hardening, as they weaken the steel by opening the grain and render it unfit to do the work it might if it were treated properly.

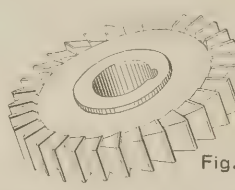
Fig. 13

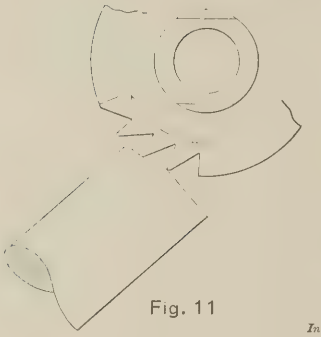
Fig. 11

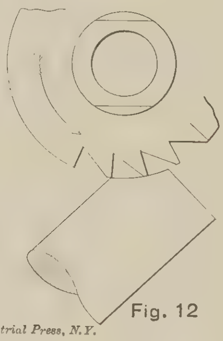
Fig. 12

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Grinding Counterbores.—All tools which are held by their shanks and which must run true when in use, must have their shanks trued after hardening. Sometimes this is effected—if the shank is left soft—by turning in the engine lathe; but generally they are ground when grinding the balance of the tool. It is customary to grind the shanks first, as it is not advisable to place a dog on a finished cutting surface if it can be avoided. Then again, if the shank is to be ground straight it affords a better opportunity to set the machine so that it will grind straighter than when grinding either the body or pilot.

The shank may be ground to dimension given on drawing, or to fit a holder, as the case may be; after which the body may be ground. As a rule when grinding the body a sufficiently smooth surface may be produced by first grinding with a coarse or medium wheel to within .002 or .003 inch of size, then finishing with a fine wheel, exercising care not to heat the piece. But in cases where this method will not produce a sufficiently fine surface, the body must be left a trifle, say .0005 inch, above size, when ground with the fine wheel, and lapped to size. For lapping work of this kind run the counterbore in a direction opposite from that in which the tool runs when in use, there being then less liability to round the front face of the tooth. It should be run in the direction of the arrow in Fig. 5.

The form of lap used for this class of work varies according to the custom in the individual shop. When lapping cutting edges it is best not to use laps made of lead or other soft metals; the stock in the laps being soft yields and does not produce good work. Yet there are many places where lead laps are very useful. Cast iron being an open-grain metal, is charged very readily with abrasive material, and, being firm, will not yield; so for most work of this character it proves very satisfactory. Furthermore, it has the advantage of cheapness, which, while it should not influence us to the extent of selecting an inferior article, should always be a consideration when it answers the purpose as well and we have many pieces to make.

The lap may be a piece of scrap iron with a hole bored through it a trifle—say .001 inch—larger than the diameter of the piece we are to lap. It should then be split and a screw hole drilled and tapped in it, as shown in Fig. 6, so that it may be closed as the diameter of the piece being ground diminishes.

If emery is the abrasive material to be used in cutting the counterbore, it is generally considered best practice to use No. 120 emery for such work as that under consideration. As the tendency of laps is to cut a piece slightly smaller at the ends, the cutting end would probably be reduced enough smaller than the body to cause it to bind when the tool was in use, thus rendering it unfit for use. To overcome this tendency a short sleeve may be made and forced over the pilot up against the body of the counterbore, as shown at *A* in Fig. 7, after hardening and before grinding. This will prevent the cutting end being made smaller than balance of body. After the piece is lapped to size the sleeve may be removed.

As the friction incident to the lapping operation will cause the counterbore to expand, that is the diametrical measurement will be increased, it would be unsafe to gage it while warm. For this reason it must be cooled off before measuring. To effect this, use water that is at about the normal temperature of the room it is to be used in—70 degrees—as extremely cold water would cause it to contract more than it should, and when restored to normal temperature it would be slightly large.

When grinding the pilot the wheel should pass over the pilot on to the groove, provided it is thin enough. Should the wheel be too wide to allow of this it can be cut away on an angle on one side, leaving a narrow cutting surface. In fact, for the class of grinding incident to small tool work it is not advisable to have a very broad wheel surface on the piece being ground.

When machining holes of various sizes to a given size—all alike—it is not necessary to make a counterbore for each size hole; one tool may be made to do the work by having sleeves that fit various sizes of holes. The holes in the sleeves should all be of the same size and all should fit the pilot of the counterbore as shown in Fig. 8, whose body will produce the proper size of hole. One sleeve may be removed from the pilot and another substituted whose diameter corresponds with the size of the hole to be operated on. If these sleeves are intended for permanent equipment they should be made from tool steel, hardened and ground to size, but if only intended for one or two holes they may be made of machine steel and used soft.

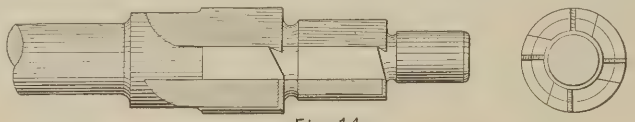
Fig. 14

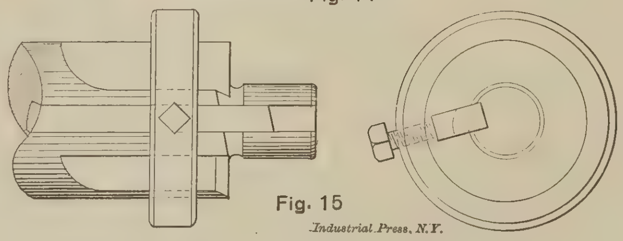
Fig. 15

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Figs. 14 and 15. Multiple Counterbores.

Inserted Pilots.—The range of work possible with a counterbore is sometimes greatly increased by having pilots of various sizes which may be inserted as occasion requires. In Fig. 9 is shown a counterbore designed to take pilots of different sizes. This form of counterbore is oftentimes used where it is necessary to sharpen quite often, as the pilot may be removed and the teeth ground on their ends. If the teeth are ground on a universal grinding machine they can be kept very straight and square. After grinding, the pilot may be again inserted and the tool is ready for use. Drill the hole all the way through the counterbore, to facilitate removing the pilot, as it may then be driven out with a set or a piece of wire. That portion of the hole that receives the pilot should be drilled, bored and reamed in the engine lathe. To accomplish this first square the ends of the piece, then turn a roughing chip over the outside. If the counterbore is large, anneal it at this stage, to do away with internal strains which will affect it when it is hardened. If it is small this precaution need not be observed. The end to receive the pilot should be run in the back rest, the opposite end being strapped against the live center.

The method of fastening work of this character against the live center varies in different shops. In some places they use yokes as shown in Fig. 10, which are made in several sizes to accommodate the various sizes of work to be done. In other shops it is customary to use a piece of belt lace. Before proceeding to strap the work make sure that the live center is a good fit in the taper hole in the head spindle, and that it runs true; then run the faceplate about one-half way off the thread on the spindle and run the lace around the dog on the end of the piece and then to the faceplate, running it back and forth several times. It is now tied securely. Then the faceplate is run all the way onto the spindle, thus creating a tension on the lace and drawing the work securely against the center. When fastening work in this manner care must be exercised that the lace does not draw unevenly, or the piece of work will not be drawn back against the center properly, but to one side, thus causing it to run out of true. For certain classes of work belt lace does not furnish a satisfactory means of holding work, but for most work it answers nicely if carefully adjusted.

If the hole to be drilled through the shank is to be done on centers, as is sometimes the case, it should be done before turning the outside of the stock, and before back resting for drilling the hole for the pilot. After drilling the hole as described, the end should be countersunk to provide a surface to run on the center when turning the piece to size. The hole to receive the pilot, however, should be machined by running the end in the back rest as described.

The teeth of counterbores of this description are usually made of the form shown in Fig. 9, so as to insure sufficient strength. It would not do to make them of the shape shown in Fig. 3, as the hole running through the tool would so weaken it that it would not stand up when in use. When cutting the teeth the counterbore may be held in the chuck on the end of the index head spindle. The head should be turned to an angle that will produce the desired shape of tooth when the cutter is fed through the piece. If the counterbore shows a tendency to raise and catch, from the action of the cutters used in milling the teeth when the cutting is started from the end, as shown in Fig. 11, the cutter may be reversed and the cut started from the opposite end of cut, as shown in Fig. 12. Under no circumstances must the cut taken be heavy enough to spring the piece. It is advisable to use a side milling cutter of the form shown in Fig. 13 when milling work of this kind.

The pilot should be made as shown in Fig. 9. The center of the portion that extends into the hole should be cut away as shown. After turning to a size .010 or .015 inch larger than finish size it may be hardened. The hardening should extend the entire length of the portion outside of the counterbore, and, as the hardening should never stop at a shoulder, it should extend a short distance onto the part that enters the hole. It may be drawn to full straw color. Grind the portion marked *A* to the designated size, and *B* to a force fit in the hole. It is apparent that on account of the nature of the tool it would not be advisable to force the pilot very hard; yet it must be forced hard enough to hold securely. After the pilot is ground to size it may be forced to place and the counterbore ground to size with the pilot in place, the pilot furnished the center to run on.

Multiple Counterbores.—Counterbores are sometimes made as shown in Fig. 14, in order that two or more sizes of hole may be made at one operation. At other times a groove is milled on one side and a blade inserted to cut a hole of a desired size. This blade is held in place by means of a setscrew and collar, as shown in Fig. 15. At times two or more grooves are cut and as many blades used. As it is necessary to have the faces of these blades radial, or a little ahead of the center—called a negative rake—it is apparent that the blades must be inserted in the slots and turned to reduce the back of tooth to the shape of the circle of the hole it is to enter when cutting.

Facing Tools With Inserted Blades.—A very simple form of tool used in facing surfaces when it is necessary to use a pilot, or guide, is shown in Fig. 16. This style of tool is often used to counterbore holes, and works very nicely where the amount of work to be done would not warrant a more expensive form of tool.

When but a small amount of work is to be done with the tool, it can be made of a piece of ordinary cold-rolled machine steel of the proper size. Drill a hole through it and ream with a reamer which will produce a hole driving size for some size of drill rod on hand. Cut off a piece of drill rod the right length, drive it in the hole and file it to correspond with shape shown in Fig. 16, to provide a cutting edge.

If the tool is to produce a flat surface, after driving the drill rod to place, back rest the end of the bar which forms the body of the tool and face one surface of the cutter square with body. Then drive it out, turn it sufficiently to give the necessary clearance, and face again to the shape shown in Fig. 16. Now take it from the holder, harden and draw to a straw color, and after replacing it in the holder the tool is ready for use. When using this form of tool for facing shoulders on work of the character shown in Fig. 17, the cutter must be made so that it can be easily inserted in, and removed from, the holder. In order to accomplish this the cutter must fit nicely in the hole, yet be free enough to allow of its being removed with the fingers, it being held in place by means of the setscrew shown in the end of the holder.

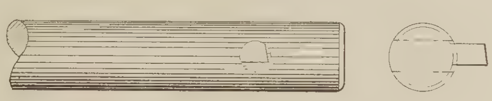
Fig. 16

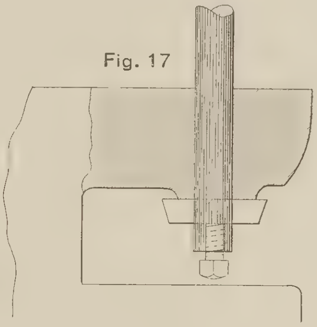
Fig. 17

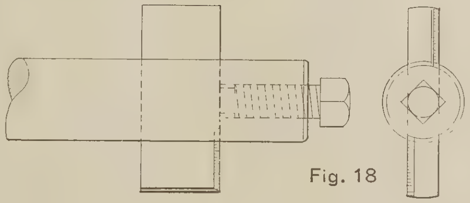
Fig. 18

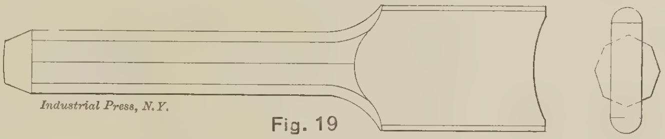
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Fig. 19

Facing Tools with Inserted Blades.

Generally when this form of tool is to be used for permanent equipment the blade is made flat, as shown in Fig. 18. The hole in holder is drilled, broached and filed to size before the holder is turned to size as it would be apt to be sprung somewhat by the operation of cutting out the stock between the holes, this ordinarily being done with a broach called a drift, Fig. 19, which is forced through the holder with a hand hammer or an arbor press. The hole is finished to size with a file. The cutter is held in place by a setscrew, as shown. Various sizes of cutters may be used in one holder, and by using sleeves of different sizes on the pilot, the range of work possible with one holder is quite wide.

Combination Counterbores.—When there is a large range of sizes of holes, yet but few of one size to be counterbored, it is customary, if the holes are large, to make "combination counterbores," making one holder answer for several sizes of cutters. With sleeves of various sizes having holes to fit the pilot at the end of holder, it is possible, by changing cutters and sleeves, to make one tool answer for quite a number of sizes of holes. Fig. 20 represents a combination counterbore, while Fig. 21 shows the holder and a sectional view of the cutter and the sleeve that goes on the pilot. The holder may be made of machine steel, and casehardened to prevent its being marred and to give it additional stiffness to prevent its springing from strain when in use. It should, of course, be left large enough all over to allow of grinding after it is hardened. When hardening it should be dipped in oil to prevent its springing and to make it as tough as possible. The tendency to spring if dipped in water would be very great on account of the key slot cut on one side to receive the key used to keep the cutter from turning when in use.

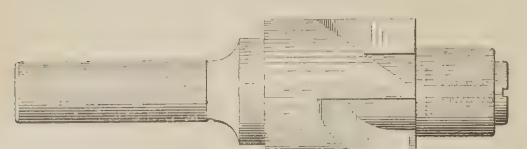


Fig. 20

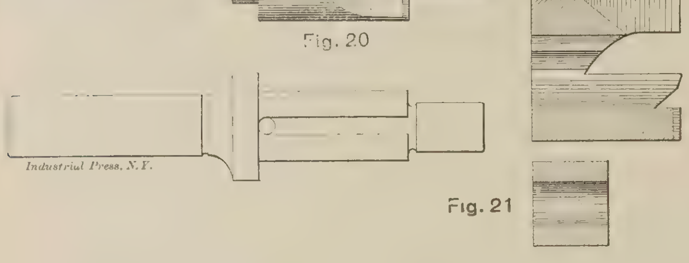


Fig. 21

Figs. 20 and 21. Combination Counterbore and Holder.

When making the cutters use a good quality of tool steel, which should be cut into lengths a trifle longer—say 1-16 inch —than the finished cutter. The diameter of the stock should be sufficiently large to allow of the removal of all the decarbonized surface portion.

Place the blank in a chuck in the engine lathe and drill and bore a hole 1-16 inch smaller than finish size through it. After this place it in an arbor and remove the outside portion by turning. It should then be annealed. Right here many inexperienced men get into trouble; they either heat the piece of steel unevenly or allow it to "soak" in the fire, or else bury it in damp lime or ashes, any one of which leads to trouble. The steel should be uniformly heated to a red heat—not a bright red—then removed from the fire and allowed to cool very slowly.

After the steel is annealed it may be placed in the chuck and the hole bored and reamed to size; or if there is no reamer of the proper size it may be bored to required dimensions. The size to which the hole is machined depends on the method to be adopted when the article is hardened. If it is to be "pack-hardened" it can be made to size; if, however, it is to be heated in an open fire and dipped in water in the ordinary manner, there should be left in the hole about .005 to .008 inch for grinding. When the hole has been brought to the proper dimensions the piece may be removed from the chuck and placed on a mandrel. The ends may now be faced to length, and the outside turned, leaving .012 to .015 inch for grinding.

Fig. 22

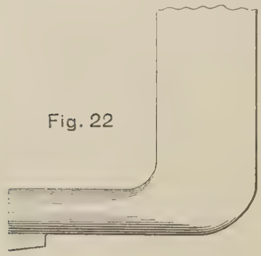
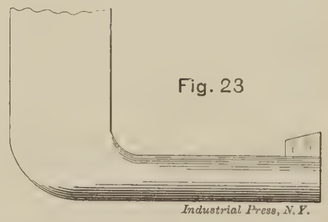


Fig. 23



Figs 22 and 23. Splining Tools.

In a former paragraph the term "arbor" was used to denote the cylindrical piece used to turn the blank on, while in the previous paragraph the word "mandrel" appears. The reason for this is that in certain sections of this country the word "arbor" is used to denote a tool of this character, while in general the term "mandrel" is employed. The latter term will generally be used in these articles when referring to a tapered arbor, forced into holes in pieces of stock, which are hereby provided with centers to turn on.

The spline cut, or keyway, may be cut with a splining tool, in the shaper or the planer. The ordinary form of tool used for this work is shown in Fig. 22. Experience has taught me, however, that best results will follow the use of a tool made as shown in Fig. 23, the difference being that the cutter is at the top instead of at the bottom. I have found this form of tool to cut faster and smoother than the other. Of course if tools like that shown in Fig. 22 are on hand in the shop it would not be advisable to make new ones, but if the tool has to be made I think that shown in Fig. 23 will give best results. Many times these tools are made with inserted cutters; these can be placed in the holder in either manner. After splining, remove the burrs, cut the teeth, and after stamping the size and any distinguishing marks on the cutter, it is ready for hardening; unless it is deemed well to drill and tap a hole for a setscrew, to keep the cutter up against the shoulder of the holder.

While cutting the teeth they may be held on an expanding arbor fitting the tapered hole in the spindle of the index head of the milling machine; or they may be held in the chuck which screws on the end of the spindle in the index head. After hardening and drawing the temper to a light straw color the cutter is ready for grinding. If the hole is to be ground to size the cutter is held in the chuck on grinding head, and by means of the internal grinding fixture shown in Fig 24 the hole is ground to size. After this it is removed from the chuck, placed on a mandrel and the outside is ground to the required dimensions.

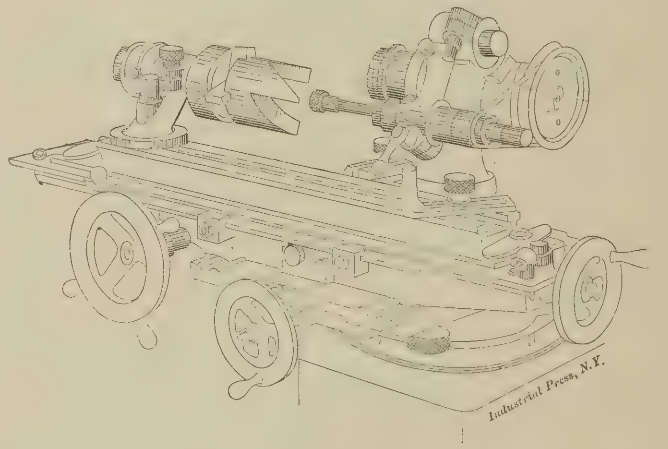

Industrial Press, N.Y.

Fig. 24. Internal Grinding Fixture.

In grinding the cutting teeth for clearance the cutter is placed on a plug and the teeth are ground sufficiently to allow of their cutting. The amount necessary to back off the cutting edges depends on the nature of the work to be done and the stock to be cut. However, for most purposes an angle of 85 degrees from a line passing through the axis would be found satisfactory. If the teeth of the cutter were cut as shown in Fig. 20, that is the face at right angle with the ends, we could state the amount of clearance as being at a certain angle to the face of tooth; but as someone might cut them somewhat spiraling and then measure from the face, and get unsatisfactory results the measurement is given from an axial line.

Straightening Hardened Steel.—When counterbores, reamers, taps and similar tools spring from hardening it is possible to straighten them by applying pressure at the convex side. It is necessary, however, to heat the article somewhat before applying pressure, in order that it may become somewhat flexible and yielding. Pieces of steel having centers in their ends may be placed between the centers of a lathe and heated with a spirit lamp, Bunsen burner or ordinary gas jet until lard oil which has been rubbed on the surface commences to smoke from the heat in the steel; then pressure may be applied as shown in Fig. 25 by a tool or piece of steel held in the toolpost, which is forced against the work by means of the cross-feed screw. The piece should be forced a trifle beyond a straight line; that is, it should be bored just a small amount the other way. It may then be cooled with wet waste. When tested if it is still crooked the operation must be repeated until the piece is straight or near enough straight to grind all right.

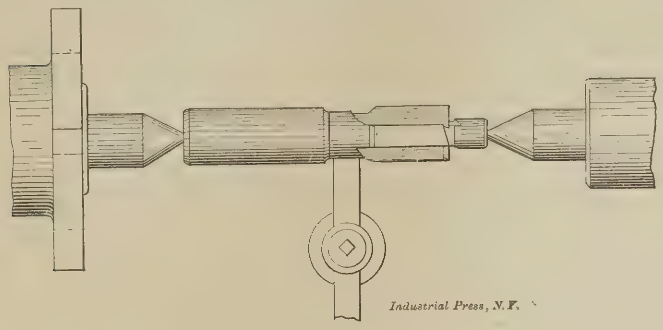


Fig. 25.

* * *

BLOWPIPE METAL WELDING WITH ACETYLENE.

In a recent consular report United States Consul Halstead, of Birmingham, England, gives an account of the welding of metals by the use of acetylene in a special blowpipe. The following is an extract of the report:

"There is now on view in Birmingham an invention for the seamless welding of iron, steel and other metals by heat produced by the burning of acetylene with oxygen. With a special blowpipe, and the mixture mentioned above, the welding of iron and steel, etc., is done in the same way "as a plumber deals with lead." The acetylene is supplied in cylinders in a state of absorption by acetone, which has the property of dissolving ten volumes of the former for each atmospheric pressure, thus obviating all danger that has hitherto existed in the compression and storage of acetylene. The separate gases are passed through valves, which reduce the initial pressure in the cylinders to about 7 pounds per square inch on the blowpipe. The acetylene when ignited produces an intensely luminous glare, which vividness disappears when mixed with oxygen, there remaining a small, greenish-blue flame, which is adjusted to the proper dimensions for producing the greatest amount of heat. The heat zone is practically only about one-eighth of an inch in length, but the temperature is so great that after a very short space of time the metal, wherever it comes in contact therewith, is reduced to a molten state and coalescence follows. Even quartz, it is stated, can be melted as quickly and blown like glass.

"Among the pieces of work done by this process was the welding, instead of riveting, of a sheet of metal intended to form the body of a foot warmer for railway cars—the joining of two pieces of metal which when rolled out cold into half thickness gave not the slightest indication of a joint. In order to test the strength of joints experiments with compressed gas cylinders have been made; these, about 6 inches in diameter, with longitudinal and circumferential seams at the ends and also a boss welded in the center, withstood a pressure of 2,000 pounds to the square inch. Although the heat produced by the fusion of acetylene and oxygen is so great, operations can be performed with the naked eye." The many uses to which blowpipe welding may be put, if successful as outlined above, make this discovery one of great value in the mechanic arts.

To supplement the above information we have secured from the Commercial Acetylene Co., 80 Broadway, this city, a brief statement with regard to the use of acetylene for welding purposes as practiced by them. A representative of MACHINERY recently saw at their factory at Harrison, near Newark, N. J., a demonstration of the intense heat of a blowpipe flame in which acetylene is the combustible agent. The acetylene is stored in tanks in which it is absorbed by acetone which has the peculiar property, mentioned above in the consular report, of absorbing several times its own volume of acetylene, and in which state the stored acetylene is said to be entirely safe to use for manufacturing or lighting purposes. One cubic meter of acetylene ($C^2H^2=26$), weighs 1 kilogram, .165, and contains in weight 92.3 per cent. of pure carbon, and yields 14,340 calories, which make 12,300 per kilogram. At the moment of entering into combustion, it is dissociated in the following elements: Carbon and hydrogen. In producing by this action 2,600 calories, the balance of the heat is furnished by the combustion of the carbon in carbonic acid and of the hydrogen in water vapor.

The theoretic proportion to insure a complete combustion of a mixture of acetylene and oxygen is, one volume of acetylene to 2½ volumes of oxygen. Recently a burner of the Bunsen type was devised by Mr. Edmond Fouche, of Paris, France, which is called "Oxy-acetylenique," which gives a flame of one volume of acetylene and 1.7 oxygen. The flame obtained from this burner presents in its center a very short and sharp point, on the extremity of which the excessive temperature obtained is above 3,000 degrees Centigrade. In this zone the flame is composed almost exclusively of oxide of carbon and of free hydrogen, whereby a fusion of metal without oxidation is obtained.

A great many large factories in Europe are employing this for welding purposes, finding it very much cheaper than the process used before; and it is also a great deal more convenient.

* * *

MANUFACTURE OF FIREARMS IN BELGIUM.

The manufacture of firearms, complete or in part, is the traditional industry of the province of Liege, Belgium. Whether the people of Liege hold the secret of turning out a prime quality of gun barrel or other integral part of the arm, the U. S. Consul at that city does not know, but it is an established fact that no other barrel of corresponding make and value can stand the strain of the severe test put upon it as well as the Liege gun barrel. Every barrel must, under the law, successfully withstand the government test before it is admitted for sale. The gun barrels are made by the workmen in their own homes, and are delivered to the merchants, who combine the parts for the markets. It is said that no less than 50,000 men, women, and children are engaged in the manufacture of gun barrels. This system of buying from the people lessens the responsibility of the manufacturer, for if the barrel fails to withstand the test the workman and not the manufacturer is the loser. The material for manufacturing the gun barrels or other parts of firearms is oftentimes supplied by the manufacturer, who sometimes gets his barrels roughly made and completes them himself.

It is the universal understanding here that the United States is the best market for the cheap grade of guns, and there is a double-barreled gun called at Liege the "American." It is estimated that in the Province of Liege about 150,000 pairs of gun barrels were manufactured during the year 1902, part of which were sent to the United States rough bored, to be finished. The exportation of gun barrels of all grades to the United States is increasing. During the six months ended August 31, 1903, there were exported to the United States firearms to the value of $234,815.71 and gun barrels to the value of $39,012.33.

Quite a controversy exists as to the better quality of gun barrel—the Damascus or the steel. The Damascus is manufactured only at Nessonvaux, near Liege, while the steel barrel is made in Liege. One argument in favor of the Damascus barrel is that in case of an explosion there is less liability of injury than with the steel barrel. Muzzle-loading guns are sent in large quantities to South America, while the flintlock is made for export to Africa. Revolvers are turned out in great numbers and are shipped to all parts of the world. It is estimated that 600,000 were manufactured in Liege last year.—*Consular Report No.* 1862.

* * *

It is not only important to know how many hours a man works on a particular job; but how many hours his machine works, as well. If the man works 10 hours and the machine only 6 hours, something is wrong. It probably means that an investment in apparatus and fixtures for handling and setting up would be profitable.

THE LE BLOND AUTOMATIC INDEX-PLATE DRILLING MACHINE.

The interesting machine illustrated in the half-tone, Fig. 1, and shown in detail in the line cuts, Figs. 2, 3, 4 and 5, is an automatic index-plate drilling machine, designed and constructed in the shops of the R. K. Le Blond Machine Tool Company, Cincinnati, Ohio, for their own use. As is naturally inferred from the name, the machine is employed for drilling the concentric rows of holes in the index-plates supplied with dividing heads, such as are usually provided with the knee-type milling machines made by the company. This work the machine does automatically, only requiring the blank plates to be mounted on the work arbor, and removed when completely drilled. The holes are accurately spaced and drilled to the required depth, and the change from one concentric row to the next is effected without the aid of the operator. Moreover, the machine is not confined to any set combination of holes—any practicable combination required may be drilled by supplying the necessary master index-plates arranged in the order desired.

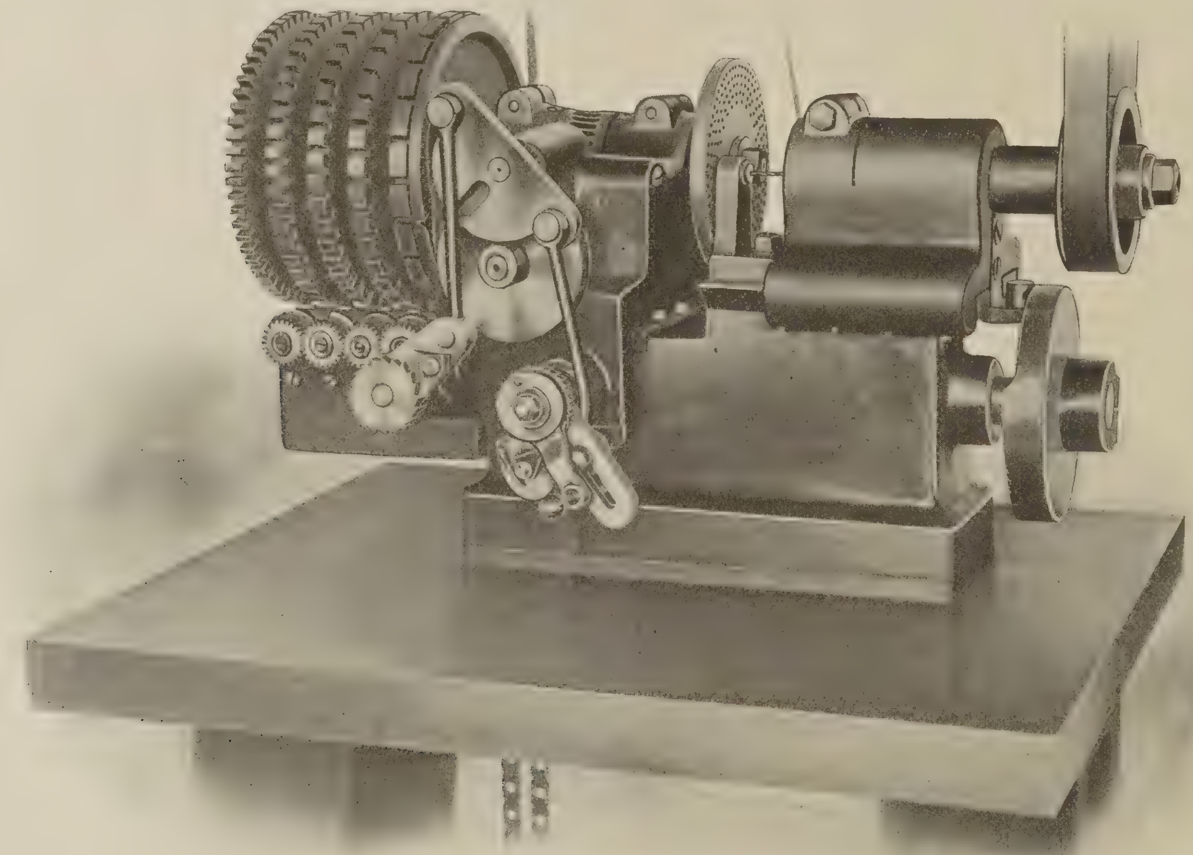


Fig. 1. Le Blond Automatic Index-plate Drilling Machine—shown large for detail.

The operation of the machine may be divided into five functions as follows: 1. Drilling the holes and feeding the drill. 2. Indexing for each concentric row of holes. 3. Rotating the blank as required for indexing. 4. Moving the blank transversely when one row of holes is completed. 5. Throwing the machine out of operation when plate is completed. Although rotating the blank is essentially part of the indexing function, it is complicated with another movement, and, for the sake of clearness, the two will be considered separately.

The drilling operation, of course, is simple, and it requires little explanation. The drill, ⅛-inch diameter, is mounted in the end of the drill spindle L, Fig. 2, without the use of a chuck, the end of the drill shank being tapered and fitted to the taper socket in the spindle. The spindle is independently driven at a speed of about 800 turns per minute. It is mounted in a sleeve or bushing which is longitudinally adjustable in the slide V to accommodate varying lengths of drills and compensate for wear. The feed movement of the slide V is effected by the disk U having a cam surface on its inner face which abuts against the friction roller u. The movement given the drill is ¼-inch, and its character is indicated in the development of the cam face at the bottom of the cut. The feed cam is mounted on the shaft N carrying the wormwheel Q, which is driven by the worm W. On the outer end of this worm shaft is mounted the driving pulley Y, Fig. 3. The slide V is retracted by the coil spring v indicated beneath it. The drill is guided by a hardened steel bushing mounted in a bracket attached to the base.

A master index wheel or plate is provided for each circle of holes drilled. These are indicated at A, A_1, A_2, A_3, and A_4, Fig. 2. Each master index wheel has as many notches cut in its periphery as are to be drilled in the corresponding row on the blank. These notches are milled so that one side is radial and the other tangent to a concentric circle about 2¼ inches diameter. Each wheel, of course, has an independent locking plunger, shown at C, C_1, C_2, C_3, and C_4. The plungers are forced into the notches by coiled springs, but all save one at a time, are restrained by the cams B, B_1, B_2, B_3, and B_4 from engaging the notches of the index plates. In the drawing the cam B is shown disposed so that the plunger C may engage the notches in the plate A. Each plunger has a rack milled out of its side, in which engage the pinions E, E_1, E_2, E_3, and E_4, all mounted on the common shaft F. Although the pinions are keyed on the shaft F, the shaft is free to turn within them through an arc of limited length, the keyways being made wider than the keys, as indicated in the section on the vertical plane e-f. Therefore when all the plungers are held down with their cams save one, say C, its pinion is the only one that receives the movement transmitted from the rack G. This movement occurs each time the master plate is to be moved one space, and is effected in a novel manner. The sprocket H carries a bicycle chain of forty links, hanging freely and filling no purpose except to carry the triangular block h. This block raises the plunger G as it rides over the sprocket wheel. The sprocket wheel has eight teeth, so it makes five turns for one traverse of the chain, and since it makes fifteen turns per minute, it follows that the plate is indexed three times a minute. This, of course, agrees with the movement of the drill spindle slide *V*, making a total of 180 holes drilled per hour.

When one row of holes is drilled the indexing action is transferred from one master plate to the next. The cams *B*, B_1, etc., are mounted on the same shafts with the pinions *D*, D_1, D_2, D_3, and D_4, which are all meshed together and which receive motion periodically from the pinion *d*. When a row of holes is completed the shaft d_1, upon which *d* is mounted, is given one-fifth turn by means that will be described further on. The effect of this movement is to depress the plunger *C* and to release the plunger C_4. (This, however, is not the sequence; the action starts with C_4 and goes to the left and returns to C_4 when starting the next blank.) The master plate A_4 is made with a sleeve upon which the other master plates are mounted and keyed, and A_4 is keyed to the work spindle *K*. By this arrangement any desired combination of master plates may be assembled together and treated as one unit when a change is to be made, etc.

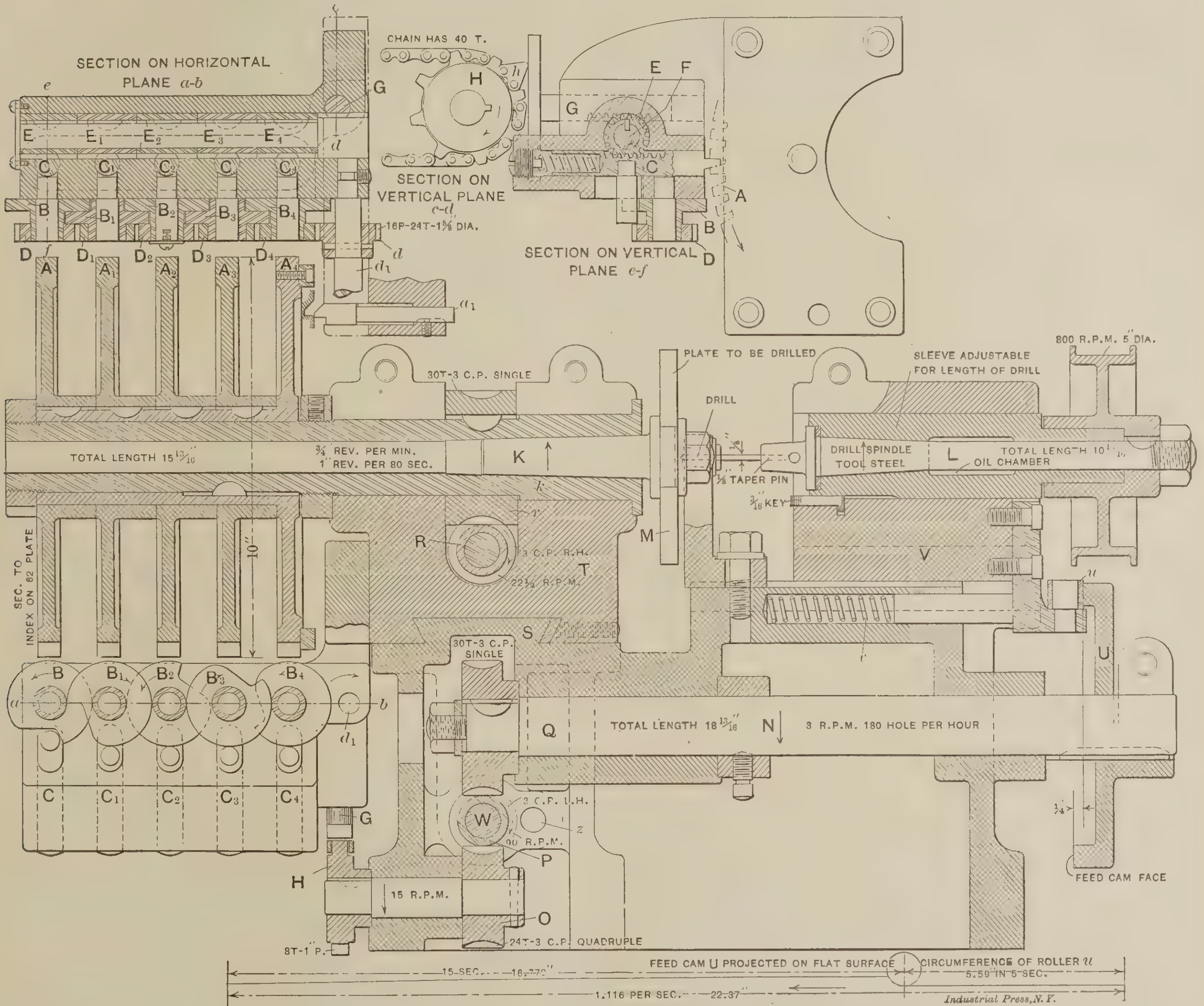


Fig. 2. Longitudinal Section through Work Spindle and Drill Spindle; also other Sections of Details.

The work spindle *K* is driven by a worm *R* meshing in the wormwheel *r*. Referring to Fig. 3, it will be seen that the shaft o_1 carries the worm *R* and that the latter is extended to the left in the form of a sleeve, at the end of which is a friction clutch o_2. The gear *o* runs continuously, being driven by the pulley *Y* through the gears *m* and *n*; also the shaft o_1, on which it is keyed. But the worm *R* can turn only when the work spindle is released by the lowering of the locking plunger engaging the master plate. When the plate is released the frictional resistance of the clutch o_2 rotates the worm and turns the work spindle one space when the locking plunger again springs into place in the next notch, and so on until the row is drilled.

Now we come to the action required for moving the blank transversely after one row of holes has been drilled. The work spindle and indexing mechanism is mounted on the slide *T*, having transverse movement on the base *S*. Partial rotation of the quadruple left-hand thread screw *j*, Fig. 3, produces the necessary movement. The genesis of this movement is the notch cut in the side of the master index plate A_4, Fig. 2, and shown in the view, Fig. 1. When the plate has made a complete turn the pin a_1, Fig. 2, shoots into the notch in the side of A_4. Its opposite end is engaged with a groove cut in the periphery of a_2, Fig. 3, and when the pin a_1 shoots into the notch in A_4 it releases a_2 and allows it to move to the right under the influence of the large coiled spring. This movement throws the clutch b_1 into engagement thereby, for the time being, locking the sleeve a_2 to the shaft o_1. The motion of the shaft is then transmitted to the disk *t*, which carries the pin t_1. This pin engages the slot in the double rocking lever t_2 and rocks it on its pivot, thereby transmitting a partial rotation to the shafts *O* and *j* through the connecting rods and ratchets *s* and s_1, Figs. 4 and 5. The left-hand ratchet s_1, operates the shaft d_1, carrying the pinion *d*, and the right-hand ratchet *s* moves the screw *j*, thereby giving the slide *T* the required transverse movement. The double rocking lever t_1 is mounted on the shaft *l*, which has pinion teeth cut on its inner end. These teeth engage a plunger *l*, abutting a coiled spring, the function of which is to return the rocking lever to its former position when released by the pin t_1. The action of *d*, it will be remembered, is necessary to change from one master index wheel to the next.

The disk *t* is stopped when it makes one turn by the plunger

a_1, which has been moved to its normal position by the passing of the notch in the side of A_4. The periphery of a_2 is cut with a groove, one side of which is inclined, as shown in the partial development at the right in Fig. 2. The end of the plunger a_1 rides along the inclined side of the groove and withdraws the clutch b_1 from engagement.

It will be noticed that a small coiled spring and a joint having a short end movement is shown in the shaft *o*, in the part adjacent to the pin a_1. The object of this, it is explained, is to provide clearance between the clutch teeth so that they will not rub and grate when disengaged. At the slow speed at which the shaft revolves there is not sufficient momentum to accomplish this as is done in other mechanisms of this kind having a high rotary speed. The clutch teeth are cut at an angle of 15 degrees, which angle opposes sufficient resistance to separation to compress the small coiled spring until the ends of the two shaft sections meet, when, of course, the cam, a_2, begins to pull the clutch faces apart. As soon as separation is effected the small spring pushes the outer shaft section with its clutch a short distance to the right so as to give ample clearance between the teeth.

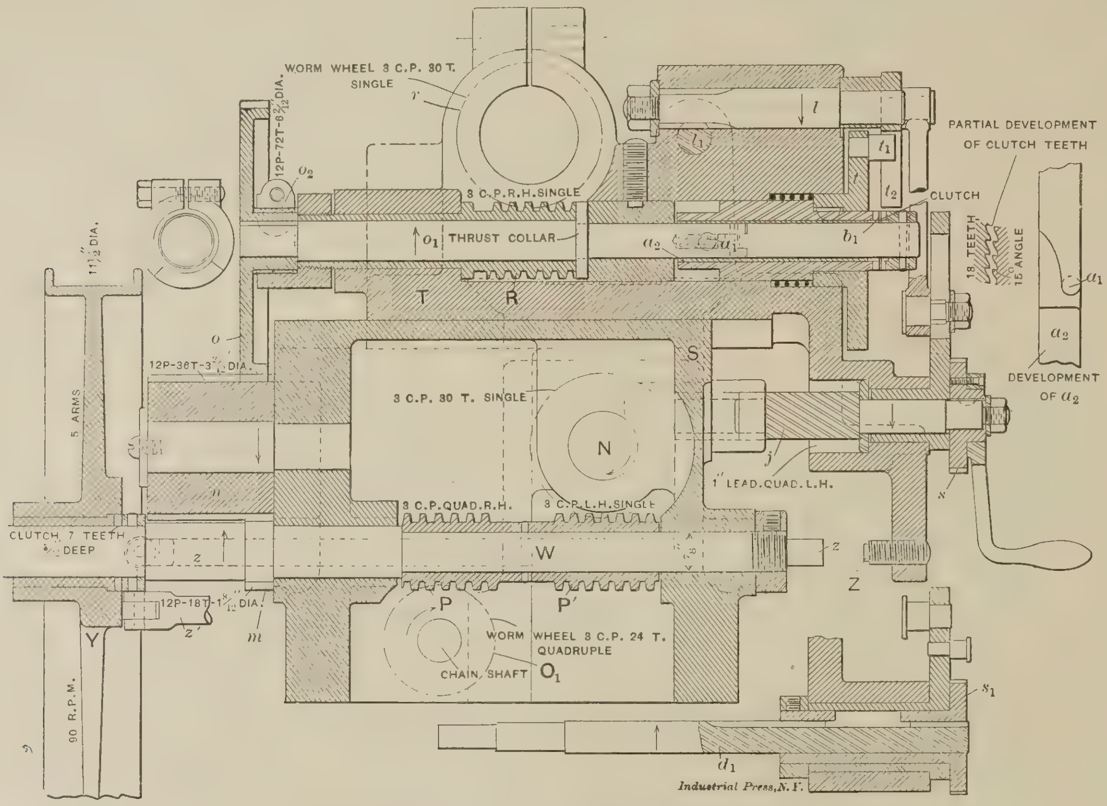


Fig. 4. Cross-section through Plane of Driving Gear, Etc.

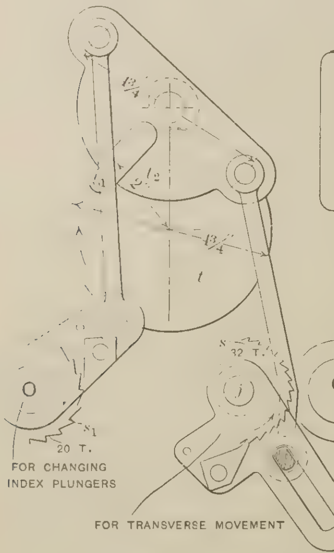


Fig. 4.

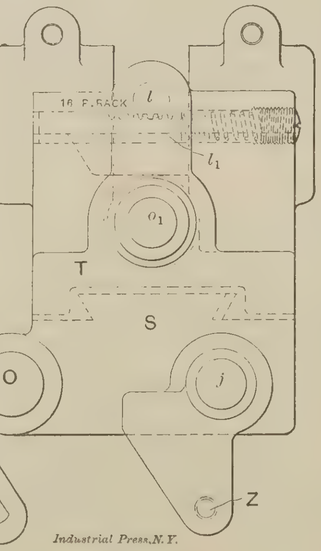


Fig. 5.

The action somewhat incompletely described in the foregoing is repeated for each row of holes. When all have been drilled, further movement of the slide *T* brings the end of the screw *Z* into contact with the end of the plunger *z*. This plunger terminates at the left-hand end in a friction roller bearing against the side of the hub of the pulley *Y*. A spring (not shown) keeps the pulley in engagement with a clutch connecting it with the gear *m*. But the action of the plunger disengages the clutch when all the holes have been drilled, which stops the machine so far as the indexing, feed and transverse movements are concerned. The drill spindle, of course, continues to run, since it is independently driven by separate countershaft.

* * *

The Austrian government has recently made arrangements for an experimental motor service on the so-called secondary railroad which connects Trieste with the town of Buje in Istria. Experiments in this direction are also being made on a number of branch roads in lower Austria and Bohemia, and are being watched by the public with a great deal of interest. Local railroads in Austria have, generally speaking, been disappointments to both their owners and the patrons—to their owners because they are not profitable; to the public because their passenger service is insufficient. The railroad motor cars, which accommodate from 12 to 20 passengers, are expected to fill a long-felt want. They are comparatively light, carry no unnecessary incumbrances, and can be operated at a very small expense. They will make a number of regular trips daily, and as many extra trips as the exigencies of the traffic may demand.—Consular Report No. 1859.

* * *

During one day—January 18, 1904—the Manhattan Elevated Railway carried the enormous number of 1,025,000 passengers. This number is a record-breaker, the road never having before carried 1,000,000 passengers in one day. The increase of traffic is an indication of the growth of the city, but it is more indicative of the greatly increased capacity of the elevated system since electric power has been substituted for steam locomotives. For instance the steam-drawn trains consisted of five cars each and about the best the management could do was to give a service of forty trains at any one station per hour. With the electric service six-car trains may be run with a headway of only one minute, or sixty trains per hour.

HOW TO DRAW UP SPECIFICATIONS, ALSO TENDER, FOR MODEL ENGINE.

GEO. PLEYDELL PEARCE.

Some readers of MACHINERY undoubtedly earn a little extra money in the evenings in the way of model making. While this work is very remunerative to anyone who sets about it in a business way, many do it in a half-hearted and unbusinesslike style.

The most important thing when arranging to make any model for your customer, is to have a complete understanding from the very first, and this must be in writing, and state exactly what you contract to do. By starting the work on a good business basis you will save both time and money in settling disputes as to whether you contracted to do this, or that, or whether the customer actually told you to put on such and such a fitting, or only thought so, and the thousand and one other little things which crop up in a matter of this kind.

For the benefit of those who do not know how to draw up a complete specification, or tender, I have drawn a sample of each, in reference to a model compound engine, with boiler, but the same style and method can be used for anything of this nature, and if those interested grasp the idea they will find no difficulty in applying it to their particular case.

Specification.

For the construction of a small working model of a compound, non-condensing steam engine, with boiler, for Mr. ——, of —— Street, —— City, ——State, to the drawings of Mr. ——, of —— Street, —— City, —— State.

29-Oct.-'03.

General Conditions.

1. Definitions.—The term contractor used herein shall mean Mr. ——.

2 Generally.—The contractor shall make all patterns and obtain all castings necessary. The engine and boiler are to be constructed as a practical working model, and the contractor is to do all work necessary to make it so, even if such work is not specially referred to or described in this specification, or on the drawing.

3. Tests.—The boiler shall be tested by the contractor to a pressure of 80 pounds per square inch. The engine shall, before being painted, be tested with steam in the presence of Mr. —— and shall run at full speed for such time as Mr. —— desires, up to the limit of two hours. Any defects which may appear in the model at these tests, due to inferior workmanship, or materials, shall be made good by the contractor at his own expense.

4. Drawings.—The engine and boiler to be made accurately to the drawing, and as described in these specifications, and if any discrepancy should appear in the drawing, or in these specifications, the contractor shall inform Mr. ——, whose ruling thereon shall be binding and final.

5. Alterations and Extras.—No alteration or deviation to be made in the construction of the engine or boiler, as described in these specifications, unless Mr. —— shall consent or order in writing, and no extra will be allowed unless previously ordered by Mr. —— in writing.

6. Time of Completion.—The contractor is to complete and deliver the model in a neat box within ten weeks of the date of order, and if the contractor shall delay the completion (except by reasons over which he has no control, in which case Mr. —— may extend the time limit to such an extent as he may think fit) he shall pay or allow to Mr. —— as for agreed and liquidated damages, and not by way of penalty, the sum of $7.00 per week, for each and every week he may delay completion of the model beyond the stipulated time (or beyond the extended time limit, as the case may be).

7. Disputes.—In case of any disputes as to any matter arising under this contract, Mr. —— decision shall be final and binding on all concerned.

8. Payment.—Payment shall be made as follows: 33 1-3 per cent. on giving order, 33 1-3 per cent. on delivering model, in complete and perfect working order, and the remaining 33 1-3 per cent. in 7 days if the engine is found to answer all that was specified. If the engine does not answer requirements the remaining 33 1-3 per cent. will not be paid till the engine has been made as specified.

Construction.

Bed.—The bed is to be made of best cast iron, machined as shown on the drawing, and accurately fitted.

Cranks.—The cranks are to be made from a best machine steel forging in one piece, polished and machined all over to the dimensions given on drawing, the bearings and pins to be made within a limit allowance of + or — .0005 inch, the rest to+ or — .008 inch.

Connecting Rods.—The connecting rods are to be made of best machine steel, machined all over to dimensions given in the drawing with a limit allowance of .008 inch.

Cylinders.—The cylinders are to be of 2-inch and 3.25-inch × 3.5-inch stroke, made of best cast iron, and machined to dimensions given, with a limit allowance of + or — .0005 inch. The cylinder covers and valve covers are to be fitted with scraped joints, which are to be steam tight, without packing or paste of any description.

Valves.—And so on.

Everything is to be entered with full particulars, and the limits allowed for finished surfaces; also, which parts are to be painted, and what color; thickness of boiler plates; quality of material; boiler mountings, etc. These forms should be made out in full detail.

The following is the tender for the same model:

Tender.

Tender for making a model compound non-condensing steam engine, with boiler, for Mr. ——

SIR.—I hereby undertake and agree to make and deliver in a neat box, carriage paid, the model compound non-condensing steam engine, with boiler, described in the drawings and specifications prepared by Mr. —— and guarantee that it shall be made of best material, and in a thoroughly workmanlike manner to the satisfaction of Mr. ——; and further, I undertake that the engine, and boiler, shall be made in accordance with the conditions, and delivered within the time named in the specification.

Signature..............
Address................ Date..........

GEORGE PLEYDELL PEARCE, Philadelphia.

It is always advantageous in contract work to have a written agreement, and above all it is desirable to have an agreement that will "hold water." We therefore asked a competent lawyer to render an opinion upon the validity of a contract drawn in accordance with the above specifications, without attempting to criticise the phraseology from a legal standpoint. We believe that a mechanic would usually do better, in drawing up his own documents, to use very simple language and avoid the strictly legal phraseology. The opinion is given below.—EDITOR.

[The foregoing probably expresses with fair clearness the actual intentions of the parties—which is the most important quality in any contract.

The absence of a *price* would, of course, be supplied, in an actual "Tender."

It may be remarked that the provision in No. 7, "Disputes," giving one party to the agreement autocratic power to determine differences, is a contractual provision that courts are disposed to regard with extreme disfavor, and will not enforce if they can find a way to avoid it. It tends too much toward leaving one party in the position of having no agreement at all. It would be much preferable to name a third person, mutually agreeable, as arbitrator.

A friendly criticism may also be made of the statement in No. 6, "Time of Completion," as to delay on account of "reasons over which the contractor has no control." This provision might well open the door for dispute and litigation, as to what causes a delay were or were not within the control of the contractor. A personal encounter between the office cat and yard dog, in the vicinity of sand molds at an inopportune moment might well cause considerable delay, and be something over which the contractor had no control. Similarly, delays incident to over-celebration, by the workmen, of local elections etc., should not be a too convenient excuse for procrastination.

No doubt the writer's intention in No. 6 is to express the conventional exemption from "fire, flood or act of God." But the intention is rather too broadly expressed, and leaves loopholes for questionable grounds of delay.—W. E. WEAVER.]

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Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.

LESTER G. FRENCH, Editor.
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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MARCH, 1904.

NET CIRCULATION FOR FEBRUARY, 1904,—25,234 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

ALCOHOL FOR INDUSTRIAL PURPOSES.

In the May, 1903, number we published a review of the possibilities of the use of alcohol in the arts, with particular reference to what has been done abroad with alcohol motors, heating apparatus, etc. It was shown that while alcohol contains fewer heat units per pound than petroleum products, something like 30 per cent. of its energy can be utilized in an internal combustion engine as against some 15 or 20 per cent. of petroleum or gasoline. Other advantages of alcohol are that it does not have the disagreeable odor of gasoline, that it is nearly or quite non-explosive and that it can readily be produced from vegetable products, making it impossible to bring its manufacture under the control of a trust.

A bill is now before Congress providing that distilled spirits of alcohol may, when rendered unfit for drinking purposes or for use as a beverage, be moved from distillery warehouses free of tax, but under suitable government regulations; "provided"—to quote the words of the bill—"that sulphuric ether, wood alcohol, methylic alcohol, wood naphtha and other similar substances, shall be mixed with such distilled spirits as to render the same unfit for drinking purposes or for use as a beverage."

In Germany similar legislation was first enacted in 1879 and a committee appointed by Congress to investigate the use of alcohol in manufactures and the arts in Germany and elsewhere, show in a striking manner the advance made by Germany in the use of denaturized alcohol. Nine years ago 85,500,000 gallons were used for industrial purposes alone as against 10,000,000 in the United States. And taking into account the difference in the population of the two countries their consumption exceeded ours by 118,000,000 gallons. It is also pointed out that Germany uses in the arts nearly twice as much alcohol upon which a tax must be paid as of free denaturized alcohol—the latter being unsuited to many purposes.

In regard to the advisability of reducing the tax upon alcohol in America it is contended that it would make so slight a difference in the cost of small quantities used for beverages that there would be no increased consumption for this purpose and that it would lead to less "moonshining," which increases or decreases according to the amount of the tax. As to these latter contentions we have no desire to express an opinion but the experience of foreign countries where denaturized alcohol is used free of tax shows that it would be highly beneficial to the industries of the United States if alcohol so modified were available here under the same conditions.

* * *

IT PAYS TO KEEP INFORMED.

In a paper read before the Institution of Mechanical Engineers in England, upon Early English steam engines, it was mentioned that at the beginning of the last century a Newcomen atmospheric engine was built and erected some years after Watt had invented and applied the important improvement of the separate condenser. The Newcomen engine used a spray of water injected into the cylinder to condense the steam and required more than twice the amount of coal that was necessary to operate one of Watt's engines of the same power.

In the closing years of the eighteenth century news traveled slowly and it is quite conceivable that, even some years after an important improvement had been commercially demonstrated, a manufacturer might be ignorant of the fact. So it was that the invention of the separate condenser, which saved 50 per cent. of the fuel used under the boiler, was not known to the builder of the Newcomen engine—and his customer had to pay the bill for his ignorance.

Such lack of knowledge of mechanical progress is impossible at the present day, thanks to the various avenues for the dissemination of information. As a matter of course the daily papers touch upon the important mechanical events and so many people travel or conduct correspondence with those in widely different localities that no one is likely to be entirely ignorant of matters concerning his welfare, even though he make no particular effort to keep informed.

Nevertheless, every mechanic who is tied down to his work, so that he cannot keep in touch with people and events through personal contact or observation, must necessarily remain more or less in the dark, unless he make a reasonable effort to find out what people are doing, why they are doing it, and how they are doing it. The detailed information upon the progress of the mechanical work is regularly and faithfully presented in the columns of the technical journals and in the proceedings of the engineering societies and the best advice than can be given to any young mechanic is to avail himself of these opportunities, which the mechanic of long ago did not have, in so far as his time and means will allow. The information thus gained is one of the things that helps one to rise to a higher position. It is not altogether what a man can do with his hands that counts; it is what he knows, and what he can do with his brain as well.

Important as was the invention of the separate condenser it is paralleled by many of the great steps of progress of the present time, as a glance at the record for fifteen years will show. This period has been marked by the development of electric street railways; the general adoption of electric traveling cranes, which made heavy machine work possible; the use of high carbon steel forgings which made large engines and generators possible; the electrical transmission of power from immense water power plants; the introduction of gas engines of large size; the introduction and use of the steam turbine; the common use of the automobile; and in shop work have come the adoption of the floor plate system, with large portable tools; the introduction of pneumatic tools; a re-designing and strengthening of machine tools, with the invention of a great number of special tools; the extension of the automatic principle to machines of larger sizes; and now, with the high-speed steels at hand, there is every indication that there will be greater changes in machine tools than ever before.

These are only a few steps of progress, selected at random, that have come into prominence within fifteen years, and they are all vital to every ambitious mechanic. We contend that no mechanic can afford to let even a year slip by without taking some time each month and week to keep informed upon these things that are sure to affect his life and work in one way or another.

SUPERHEATED STEAM.

In another part of this number is an abstract of a paper by Prof. Storm Bull, of the University of Wisconsin, upon the use of superheated steam. Prof. Bull contends that we must adopt boilers with superheaters, and engines capable of using superheated steam, if we are to remain on a par with European practice. In explaining the advantage of superheated steam he states that the heat lost by the steam in an ordinary engine increases very rapidly with the adherence of moisture to the internal metallic surface of the cylinder. If that surface can be kept dry there is very marked decrease of condensation. With superheated steam there must, first of all, be considerable heat lost before there is any condensation and before any moisture is formed. In other words, superheat prevents initial condensation of the steam. He states that to obtain the best economy at least 200 degrees of superheat should be used, and this requires engine valves of special construction, such as poppet valves—those of the Corliss type being adapted only for superheat up to about 150 degrees. In answer to an inquiry as to whether changes were necessary in valves, fittings, etc., he says that it has been his experience that rubber gaskets of the best quality are highly suited to the purpose. He has had no trouble whatever with valves of the ordinary types.

In commenting upon the paper Mr. A. Sorge, Jr., who has had an opportunity to study conditions abroad, pointed out that the situation in Europe is considerably different from that in this country. There, labor is cheap and fuel expensive, while here labor is expensive and fuel cheap. He says that after talking with engineers abroad he found they had doubts as to whether, taking all the conditions into account—such as repairs, extra attention, necessary lubrication, etc.—the use of highly superheated steam was, after all, advantageous, although he did not wish to convey the opinion that he was not an advocate of superheated steam. He believed that in the end it would be of great value and economy, but was considering the situation as it now exists.

In reply Prof. Bull states that most plants constructed during the last five years in Germany use steam of at least 200 degrees superheat and the results with respect to lubrication and maintenance seem to be satisfactory. He also has had an opportunity to view conditions abroad and says that he has found that neither the question of repairs nor of extra labor is an important one. While repairs are necessary and the cost of installation is somewhat more, these will be small compared with the annual saving. He does not consider extra labor to be necessary in a superheated steam plant and believes that the low price of labor in Europe and its high price in this country has little to do with the adoption of superheaters in our power plants.

In the matter of fuel it would not pay to install a superheater next to a coal mine where, for instance, the coal cost $1 or less per ton but, just as in Europe in a great many places, so in this country, fuel is sufficiently expensive to make it pay to use superheated steam and the most economical engines. Superheaters, however, have been installed in Germany in the power plants of coal mines and have been highly satisfactory. With reference to lubrication these difficulties have been entirely overcome since the introduction of the heavy mineral oils which evaporate only at very high temperatures, and are well adapted to superheated steam engines.

It may be said in this connection that one of the best-planned and most attractive—although not among the largest—mechanical laboratories in this country is to be found in the University of Wisconsin, where Prof. Bull is located, and one of the pieces of apparatus is a compound steam engine, with poppet valves, built by the Nordberg Mfg. Co., Milwaukee, Wis. This has been subjected to test under superheated steam and affords an excellent opportunity for obtaining results under working conditions. A paper has been promised by the same author, at a later date, upon the use of superheated steam in connection with turbines, which we trust will contain as valuable information upon this subject as he has given us on superheated steam as applied to piston engines.

NOTES AND COMMENT.

Among the suggestions that have reached the editor's desk this month is the following from a designer of machinery. He says, "I have never had access to the methods of computing the cost of machinery and would suggest that articles on how to determine the cost of brickwork, stonework, steel buildings, cranes, machine tools, etc., would interest a large number of the readers of MACHINERY." The subject of estimating is one upon which very little has been published and we should be pleased to hear from readers experienced in this work, with a view to securing data for publication.

The editor of the *Mechanical Review* is very much incensed at an advertisement of the Pacific Coast Foundry, of Los Angeles, Cal., which appeared in the *Los Angeles Mining Review*. It is headed in bold black type "That English Pig," and goes on, "Is the best pig iron for making good machine castings, etc." The editor believes that such offensive advertisers deserve only the contempt of all decent business men. Evidently our English contemporary is not in sympathy with modern advertising dodges, but it nevertheless seems somewhat puerile to take offense at an advertisement which as a whole pays a fine compliment to an English product.

In a recent issue of the *Electrical Review* a seemingly innocent article was published, entitled: "Electricity in Siberia." The ubiquitous censors of the Czar must have taken a different view of the article, however, or rather of an illustration of a vertical steam engine that accompanied it. The cut was carefully blotted out leaving only the base exposed to view, but the descriptive matter was left untouched. It is hardly possible for us to fathom the workings of the Russian mind and we can only guess at the reason, but perhaps the intelligent censor imagined that an infernal machine or suggestion of one was hidden in the valve gear.

A curious contention has been raised in London with regard to the speed of automobiles. Under the present laws the highest speed at which an automobile can be driven within the city limits is 10 miles an hour and to emphasize what is held by automobile enthusiasts to be the absurdity of the law, four motormen of electric street cars were arrested and fined for exceeding this speed limit of 10 miles an hour. It is contended that if automobiles are restricted to 10 miles an hour trolley cars should be restricted to 7 miles an hour, for the reason that automobiles can not only stop within a much shorter distance but can steer clear of any danger, while an electric car has only one way of avoiding danger—that of using the brakes. This argument would be a good one were it not for the very fact mentioned, that a trolley cannot go around an obstacle, but must follow the tracks. It does not need to go around obstacles, because drivers of other vehicles knowing what part of the street it is to pass over get out of the way themselves.

Those inclined to superstitious beliefs have, we believe, quite unanimously associated the black cat with witchcraft and other occult trades, but we were scarcely prepared for the demonstration of destructive power emanating from a black cat's fur, alleged to have occurred in New York some time ago. It has been the custom to periodically "round up" all stray cats and dogs wandering about the city and put them to death in an iron box filled with gas. In shaking a large black tomcat from the basket into the lethal chamber it is believed that an electric spark was discharged from his fur; at any rate the "despatch" exploded with a flash and bang, causing disastrous results to the cats and bystanders. Three men were badly hurt, and the ceiling of the room is said to have been profusely decorated with cat remains in all states of dilapidation. If this cat story is based on fact it may explain some mysterious fires that have been caused by an unfortunate combination of cat fur—black or otherwise—and an explosive mixture of air and gas.

THE QUESTION OF POWER AT THE ST. LOUIS EXPOSITION.

There is widespread dissatisfaction among manufacturers who expected to exhibit machinery at the St. Louis Exposition, in regard to the recent decision of the directors to charge a flat rate of $10 per horse power per month for electric current. This charge is to be based on the rated capacities of the motors with which the various machines are equipped, without regard to the actual amount of power consumed, which we believe to be an injustice that must at once be apparent to those familiar with the practice followed in attaching motors to machine tools, woodworking and many other classes of machinery, that must be shown in operation to make their display effective.

Take the case of a machine tool builder who wishes to show several machines, any of which may be operated when it is desired to show their merits to a prospective customer. These machines may require from ¼ to 2 horse power at different speeds when running light and perhaps 1 or 2 horse power additional when they are at work cutting metal. Or if, as would be likely, the manufacturer wanted to be able to demonstrate the stiffness of his machines by using high-speed steel, still more power would be necessary upon occasion. Now this manufacturer might, if he chose, install a single 6- or 8-horsepower motor, connected up with a lineshaft and countershafts, and thus have to pay only for the rated power of this one motor, which would be sufficient to drive one or two machines at a time under all conditions. But that is not the way the tools would be equipped. At the present state of the art independent motors would be provided, each one of a capacity sufficient to operate its machine when performing the heaviest work that it would be called upon to do. The result would be that several motors averaging several horse power each would be required, and although not more than one or two would usually be running at the same time, and these usually much below their rated power, the exposition management would require this man to pay continuously during the time of the exposition for the aggregate power of the several motors—a sum that we know would be practically prohibitive to the average builder of machine tools.

This requirement is bad enough in itself; but coupled with it is apparently a complete reversal of the policy of the exposition officials, which has been sprung on the unsuspecting exhibitors at the eleventh hour. When manufacturers were solicited to take space in Machinery Hall, representatives of the exposition, as well as printed matter issued by its management, conveyed the impression that the charges for power would either be very slight, or else that there would be no charge at all—the latter being the understanding of many firms who arranged to take space. In fact, the printed blank supplied by the management to be filled out by manufacturers in applying for space, contains the positive statement that "the director of exhibits and the director of works in their discretion are authorized to furnish gratuitously to exhibitors a limited amount of power for the operation of machines and processes." While under ordinary circumstances it would be expected that power would be charged for, the inference was so clear from the statements made that the St. Louis Exposition would be an exception in this respect, as to make the recent ruling a complete surprise and to cause vigorous protests from many concerns.

The matter was first brought to our notice by manufacturers in the machine tool field, who called attention to the features of the case which have been pointed out above. Inasmuch as it was our own understanding, also, that free power was to be supplied in any reasonable amount, we addressed a letter of inquiry to a list of machinery manufacturers whom we knew were intending to take space at St. Louis, asking for their experience in this connection and for an expression of their opinion. We also wrote Mr. Thomas M. Moore, chief of the Department of Machinery at St. Louis, whom we have always found willing to give courteous attention to everything pertaining to the interests of the exhibitors, citing what we had heard and what our own impressions were, and asking for a letter of explanation for publication.

Those written to have quite generally replied—some at considerable length. In a few cases no positive opinions were expressed, either because very little power would be required, and so the matter had not received attention, or from some similar cause. One machine tool builder said, simply, that he had no complaint to make, and three others that they had supposed in the beginning there would be a charge for power. These are the only ones heard from who intimate previous knowledge of this, and they do not state that their expectations were based on any specific information. We doubt that such information was actually given, because from what we can learn we believe it was the original intention to furnish a reasonable amount of power to exhibitors, gratis.

The balance of the letters are unanimous in their expressions of surprise and disapproval at the course now taken. The following comments from manufacturers prominent in the trade, and Mr. Moore's letter, while only part of those received, fairly represent the general sentiment and are so directly to the point as to make interesting reading:

COMMENTS BY MANUFACTURERS AND LETTER FROM MR. MOORE.

We were a little surprised at this request from the St. Louis managers, but are not interested in it at the present time as we have decided not to make an exhibit excepting in connection with some motor builders.

It was our understanding that power was to be furnished free until quite recently when we learned there was to be a charge made for same. We might also add that we have decided not to exhibit.

In our humble judgment, this exorbitant charge of $10 per month per horse power will be the cause of considerable friction between the exhibitors and the management. If we had made an exhibit, as we had intended, the cost to us for power would have been in the neighborhood of $1,500 for the six months.

The most objectionable feature, from our point of view, is that while we may see fit to install motors aggregating 15 horse power, our consumption of power is unlikely to average more than 4 or 5 horse power, but according to the published rates we must pay for a continual supply of current equaling the aggregate power shown by the name plates of all our motors.

We beg to state that there are plenty of kicks to be registered as to the charge for power at the St. Louis Exposition. We have not yet arranged for power and it is a question with us whether we shall arrange to run our machines at all at St. Louis. The Exposition is certainly not treating the manufacturers fairly in this matter and we are very glad to see you taking the matter up.

We were led, through printed matter or conversations, to think space and power would be free to exhibitors at the St. Louis Exposition, and we were not informed that a charge was to be made until we received yesterday from the exposition company their rules and regulations in which we see a very large charge for horse power is to be made, and it looks to us as if they were looking to make a large profit of 50 or 75 per cent. from this source. The result will be we shall use very little power.

We do not know much about the original offer to supply power free by the World's Fair at St. Louis. We do know that they now ask us $70 per horse power for seven months, with certain discounts for large quantities, varying from 10 per cent. to 28 per cent. Worse than this, they rate the power by the sum of the nominal power of all the motors used, although there may be but a few of them running all of the time, and these not anywhere near up to their full capacity. We are now trying to get the management to say that if we have a number of motors, one upon each machine exhibited, and run them only one at a time, leaving the others idle, we shall be charged for the rated horse power of the one running. We do not yet know how this matter will come out, but if as first mentioned the cost would seem to be prohibitive.

The following Letters assert that Positive Promises were Made with regard to the Charge for Power.

Our space at the St. Louis Exposition was applied for with the understanding that there would be no charge made for power or lighting. This was told us officially by one of the representatives of the Exposition who called upon us a year ago, and by referring to the "Rules and Regulations Governing Domestic Exhibitors," which formed a part of the application blank for space, in the item next below the middle of the second column, we read as follows:

"The director of exhibits and the director of works in their discretion, are authorized to furnish gratuitously to exhibitors a limited amount of power for the operation of machines and processes. The character of the exhibit requiring power for its operation will have much to do with determining the amount of power that will be furnished gratuitously."

In their pamphlet entitled "Division of Exhibits—Department of Manufacturers," Circular No. 1, on page 8, under this heading, "No Charge for Power," we read as follows:

"While reserving to themselves the right to charge for power, the administration is prepared to furnish it free when considered proper, as well as light and such other facilities as may seem reasonably necessary for the best presentation and operation of a desirable exhibition."

It was in view of the facts mentioned above that we applied for space at the St. Louis Exposition.

It is true that the earlier advertisements and announcements of the St. Louis Exposition proposed to furnish us power free of charge. It is also true that they now propose to charge us substantially, as you state, $10 per horse power per month. We recently discussed this proposition with the authorities at St. Louis and the only explanation they make is that the Exposition is assuming larger proportions and the expenses are running heavier than they had anticipated, and they felt it absolutely necessary to make this charge.

Candidly we believe the expenses of the exhibit as a whole will run about the same, or at least not a great deal in excess of other expositions; but it was, in our opinion, a great mistake on the part of the management to represent to exhibitors at the time of soliciting their co-operation that there would be no charge for power, and at this late date come in with an exorbitant charge, and we really believe it is going to have the effect of withdrawing some of the exhibits and curtailing very much in magnitude and appointment a great number of others.

We have had some correspondence with other manufacturers along this direct line, and they are all of them, in so far as we have any knowledge, feeling about the matter just as we are, only some of them stronger.

Our chief objection to the action of the exposition authorities is that they did not notify us until practically the last moment what the charges for power would be, or in fact, that there would be any charge at all; and that the literature first sent to us was such as to lead us to believe that light and power would be furnished free of charge. You probably have a copy of circular No. 1 issued by the Department of Machinery and by looking over this you will see that while no specific promise is given, it would lead one to believe that light and power would be supplied free of charge for such exhibits as require them for their proper display. The following quotation from this circular will probably make clear this point:

"The Louisiana Purchase Exposition proposes to depart from the usual practice of fairs and expositions and to make no charge for exhibit space and—within the discretion of the Director of Exhibits and the Chief of Department directly interested—to abolish charges for power, light and such facilities as may seem reasonably necessary for the best presentation and operation of a desirable exhibit."

Further, on page 10:

"There will be no charge for exhibit space, and none for power whenever the exhibit shall be deemed worthy of this concession, and motion is required for the proper illustration of the machine or process."

A Conservative Statement which Fairly Represents the Situation.

Our application for space was sent in about the middle of last summer, at which time nothing was said as to the charges to be made by the authorities. We wrote several times, asking what had been done with our application, but it was not until the first part of this year that we were definitely advised that space had been allotted to us, although we had been notified that our application would probably be favorably considered.

With this in view, we went ahead and got out several of the machines which we intended to exhibit and practically completed arrangements for installing our exhibit. After this had been done, we received a copy of the rules and regulations governing the light and power service, from which we find that the charges for power would be $10 per horse power per month, subject to certain discounts for the use of large quantities.

We also found about this time that it would be necessary for us to place the floor on our exhibit space, as none would be provided by the authorities. The expenses we had previously counted on, such as freight charges, cost of installation, attendance, maintenance, etc., would in themselves amount to a very considerable sum and when these other items were added, which we had not previously deemed necessary, the total was swelled to an amount which seemed to us to be entirely too large for the benefits that we could expect to receive and in consequence we gave up the whole idea of making an exhibit.

In other respects we have no fault to find with the treatment accorded us by the exposition authorities, but it does seem that they should have notified us at the outset as to the probable charges for power and any other expenses that might be reasonably considered necessary.

It may or may not have been a wise policy on the part of the exposition management to establish a charge for power in connection with the machine tool exhibit, which cannot be properly presented unless the machines are shown in operation, but we know that so far as we are concerned it resulted in keeping us out entirely; and we understand that it had the same effect on a number of other concerns.

The reply from Mr. Moore, chief of the Department of Machinery, with regard to the complaints of exhibitors, is as follows:

Explanation by Mr. Moore, Chief of the Department of Machinery.

You will observe from the copy of our Rules and Regulations regarding service of Power, etc., that there is a flat rate of $70 per horse power (or $10 per horse power per month) for electricity. This, however, is subject to quantity discounts which to large users will bring the cost down to $50 per horse power for the seven months' term of the Exposition. By roughly counting 200 ten-hour days as the term you will find the cost is 2½ cents per horse power hour. Such a rate, or even the maximum rate of about 3½ cents per horse power hour, surely cannot with justice be considered a grievance by any reasonable man. It is less than one-half of what the energy actually costs us, for we have all of our installation and dismantling expenses to average in the short run of seven months, and these expenses far exceed the cost of operation.

Those who complain of this rate should look up the rates charged at other great International Expositions. They should further remember that we have to install the machinery capable of delivering the maximum power which can be demanded of us at any one time. Consequently we cannot provide metered service, for on special days the demands on us would probably be ten times the average load and the daily load would only be on for a few hours. We cannot arrange for an intermittent service, that is for one exhibitor running certain hours and then shutting off in favor of another exhibitor, for when an exhibitor has a prospective customer he will demonstrate then, regardless of consequences to the Exposition or the other exhibitors.

With the growth of the Exposition it was found that if power were to be furnished gratis at least fifteen thousand horse power capacity must be furnished in addition to our already exceptionally large equipment, for to furnish power free to one practically meant furnishing it free to all. Further, it was not only a case of machinery equipment but of additional buildings to hold it and the time wherein to install it. The impossibility of such a situation became evident, so the Exposition practically divides the cost and charges exhibitors for current which is held available for their use at all open hours.

If exhibitors will study the situation carefully and intelligently they must admit this Exposition is conserving their interests and is most liberal in its provisions for their accommodation. There are no monopolies, no petty impositions; on the contrary the whole attitude and endeavor is to afford all a fair and abundant opportunity to join with the world in showing the progress of the world. The instances are very few wherein exhibitors cannot accomplish all reasonable demonstration at a very small expense of power. When the situation is investigated it usually results that whereas fifty horse power was estimated as the minimum of free power required, five horse power of purchased power will suffice for the real need of the same exhibitor. The case has yet to be discovered where our power charge has forced out or been really burdensome on an exhibitor. When sifted down to a fairly conservative and economical basis our power charge is relatively a mere bagatelle and not equal to 2½ per cent. on the average value of exhibits.

In our judgment Mr. Moore's letter does not meet the objections raised by exhibitors, so clearly presented in the letters which we publish. It will not satisfy the firms who were promised free power when they were solicited to take space and it will not make them feel that it is just to pay for several times the amount of power actually required at any one time, however reasonable the rate per horse power hour may be. These are the points at issue.

Mr. Moore's statement that it "is yet to be discovered where our power charge has forced out or has been really burdensome on an exhibitor" is far from correct, for we know that it has done both. In view of the avowed determination of the Department of Machinery to conduct their affairs on a broad and liberal basis, free from petty impositions, we trust they will find it expedient to reconsider their ruling in respect to the power charges, in the same broad and liberal spirit that has dominated their course in other directions. We believe it has always been their intention to work for the best interests of exhibitors, in so far as lay in their power.

A MILLING CUTTER WORKING ON A NEW PRINCIPLE.

In the September, 1903, issue announcement was made of the manufacture of a new line of heavy slab milling machines in the United States by the Hess Machine Co., Philadelphia, Pa. Not the least interesting feature of the new machine is the cutter which works on what is declared to be a distinctly new principle as applied to milling machines.

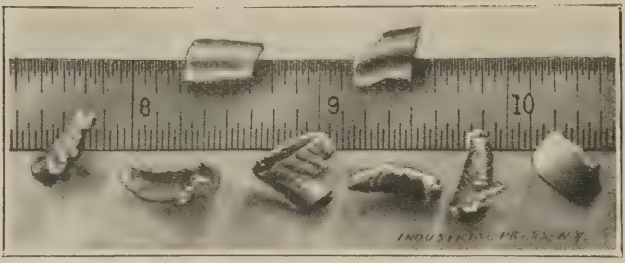


Fig. 1. Characteristic Chips Photographed Full Size.

The action of the ordinary milling cutter produces chips that are relatively wide and thin. Each successive tooth removes a chip having a length equal to the full width of the cut and of wedge-shaped section. The feed per revolution of the cutter is divided into as many chips as there are teeth in the cutter. Of course if the teeth are nicked the continuity of the chips is broken, but the action is substantially the same. Again, cutting the teeth on a spiral does not change the action materially; the most it does is to make the turning moment uniform and to preserve a constant upward thrust, which means a more even cut, freer from chatter marks than would be produced by a straight-toothed cutter under the same conditions.

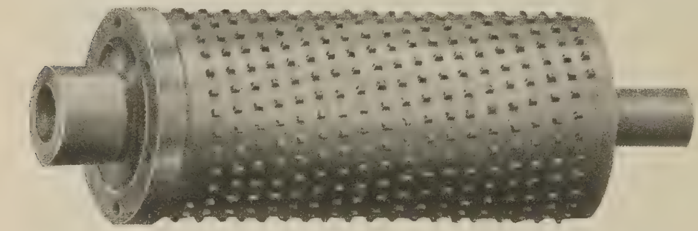


Fig. 2. Hess 15-inch Inserted-tooth Milling Cutter.

One obnoxious result of the ordinary cutter action is the heavy thrust at right angles to the work; heavy as compared with the power required for the cut, and as compared with the upward thrust against the point of a roughing planer tool removing the same amount of metal per minute. So heavy is the upward thrust that it is scarcely possible to prevent quite perceptible deflection of the work downward and of the cutter upward when working heavy wide cuts. Even on the heavy type knee milling machines the deflection on heavy cuts is sufficient to make the cutter "hog" into the work perceptibly when passing from a broad to a narrow surface. One reason for the heavy upward thrust is that the common cutter working with the feed against the cut has a wedge action. The cut of each tooth is started on the thin edge of the wedge-shaped chip and the tendency is to slide over the metal instead of biting into it. This action is often quite noticeable, even with a sharp cutter, when first starting a thin surfacing chip over a broad surface. Now if a milling cutter could be made so that the chips produced were narrow transversely and thick vertically instead of long transversely and thin vertically the result undoubtedly would be a reduction of the upward thrust for the same amount of metal removed per unit of time. (An imperfect illustration of the difference is that of a broad lathe tool taking a broad shallow chip, and a thin side-cutting tool taking a narrow deep cut. As anyone knows who has turned slender shafts the latter type of tool springs the work far less when removing the same amount of stock per minute.

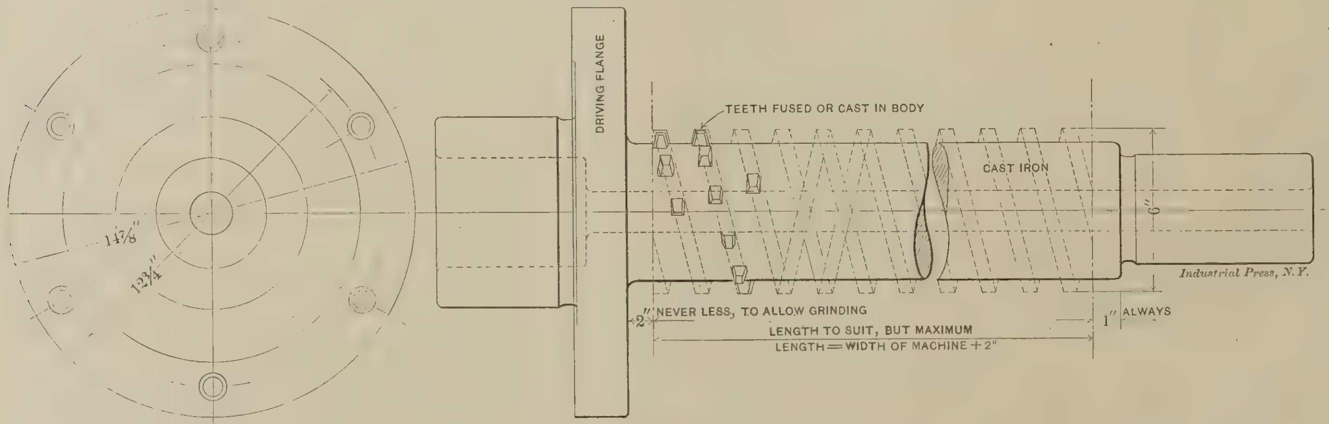

DRIVING FLANGE
TEETH FUSED OR CAST IN BODY
CAST IRON
14⅞″
12¾″
6″
2″ NEVER LESS, TO ALLOW GRINDING
LENGTH TO SUIT, BUT MAXIMUM
LENGTH = WIDTH OF MACHINE + 2″
1″ ALWAYS
Industrial Press, N.Y.

Fig. 4. Details of Hess Milling Cutter, 6-inch Size.

The Hess milling cutter removes the metal in a series of narrow chips, the cut of each tooth being narrow and deep, similar to that of a planer roughing tool. A photograph showing some characteristic chips taken from tough steel locomotive rods is reproduced in Fig. 1. The chips were removed while working on the ends of two rods which made the total width of the cut 20 inches. The depth of the cut was 5-16 inch and the rate of feed was 4 inches per minute, which makes the stock removed 25 cubic inches per minute.

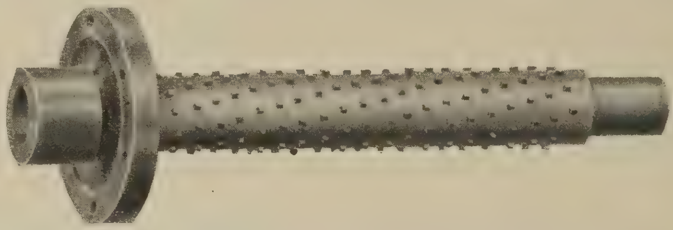


Fig. 3. Six-inch Cutter. Note Position of Teeth as Compared to Fig. 2.

The cutter is not mounted on a keyed mandrel as is the usual milling machine practice; instead, the outer end of the cutter body is formed into a journal supported by an outboard bearing, and the other end carries a large boss fitting into the end of the massive driving spindle. The end of the driving spindle is a flange 15 inches diameter and a corresponding flange is cast on the cutter. The two flanges are united by six bolts equally spaced on a circle 12¾ inches diameter thus applying the turning torque of the driving spindle at the end of a radius longer, usually, than that of the cutter. Figs. 2 and 3 show a 6-inch and a 15-inch cutter, the latter being the largest made, the diameter of the driving flange limiting the diameter of the cutter. The teeth are made of high-speed steel capable of working successfully at a cutting speed of 60 feet per minute. They are cast or fused into the cast-iron body by being placed into the mold and the metal poured around them.

Fig. 4 is a cut made from the working drawing of a 6-inch cutter and shows, at the left, the boss which fits into one end of the driving spindle; the driving flange; the outboard journal at the right; and the characteristic arrangement of the rows of teeth. The teeth are usually arranged in a double right-hand helix having a lead of 3 inches. The pitch of the helices or threads of teeth is, therefore, 1½ inch. Since there are two rows or threads of teeth there are only two teeth in the same transverse plane and each tooth takes a

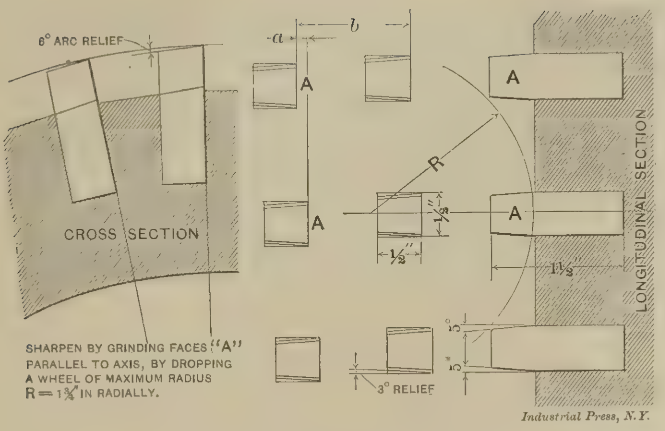

6° ARC RELIEF
a
b
A
A
A
A
CROSS SECTION
LONGITUDINAL SECTION
R
1/2"
1/2"
1 1/2"
5"
5"
3° RELIEF
SHARPEN BY GRINDING FACES "A" PARALLEL TO AXIS, BY DROPPING A WHEEL OF MAXIMUM RADIUS R = 1 3/8" IN RADIALLY.
Industrial Press, N.Y.

Fig. 5. Details of Teeth one-half Size.

cut whose thickness in the direction of feed is one-half the feed per revolution of the cutter. Since the paths of adjacent teeth overlap it gives each following tooth a smoothing action so far as its lapping portion is concerned. But the thickness of the chip taken by the lapping part of a tooth is thin as compared with the principal chip. The cutting action is very similar to that of a gang planer tool, each tooth having more of a side-cutting than of an end-cutting action. Consequently the thrust at right angles to the work is proportionately reduced. A severe test showing the absence of upward thrust was made while working on the locomotive rods referred to, the feed being stopped for five minutes while the cutter continued to revolve. During that time it sunk below the general surface only about .005 inch.

The teeth are reduced to one-half actual size in Fig. 5, which also shows the angles of relief, clearance, etc. The development of two threads of teeth (3 inches lead, 1½ inch pitch) of a 6-inch, 10-inch and a 15-inch cutter, one-eighth size, are given in Figs. 6, 7 and 8.

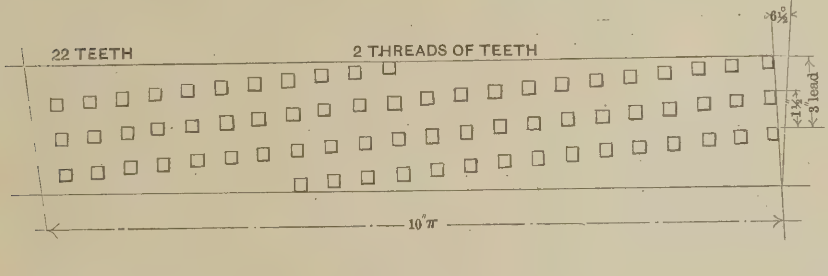


Fig. 6.

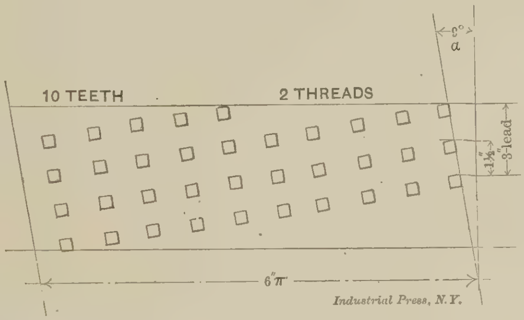
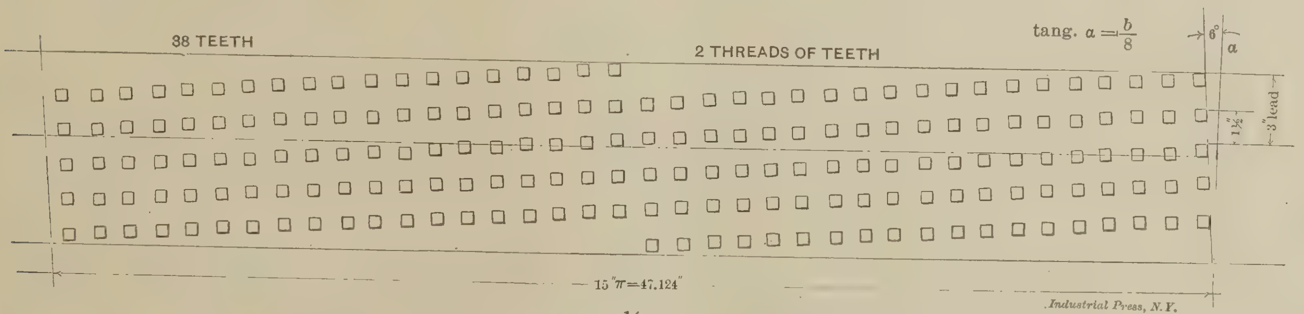


Fig. 7.



⅛ SIZE

Fig. 8. Development of four Threads of Teeth, 15-inch Cutter.

HIGH SPEED STEEL.

E. R. MARKHAM.

There are very few progressive shops that have not tried the experiment of reducing the cost of removing stock from material being worked to shape in the machine shop, by means of the modern "high speed steels."

In many cases the results have proved all that could reasonably have been expected, in other cases the results have been anything but satisfactory to the party making the experiment, and as a consequence they have condemned the steel in no uncertain manner.

Modern competition has rendered it necessary to reduce the cost so far as possible in the shop. "High speed steel" furnishes a means of doing this on the lathe, planer and similar machines by making it possible to run at higher speeds, and use coarser feeds. When we use tools made from carbon or tempering steels it is not advisable to exceed certain speeds and feeds or the cutting tool becomes heated, and the temper is drawn to a degree that makes the cutting edge too soft to stand up to the work.

The high speed steels are not materially softened when heated by use in cutting, and consequently hold their edge when heated to a degree that would soften a carbon steel tool so it would be unfit for use until rehardened.

Not only is this form of steel recommended for tools used in removing quantities of stock at high speeds on the lathe and planer, but it is claimed that many times the amount of work can be done with such tools as milling machine cutters, taps, drills, dies, etc., if made from this steel over tools made from carbon steel.

In many cases that have come to the writer's notice it would seem that the parties advertising this steel were indiscreet in claiming as much as they do for tools made from it; had they claimed one-half the gain they advertise, the results would have been ample to warrant parties making the experiment. And many times tools have been made and machines sped up to the limit claimed, and when the tools gave out in a few minutes the party would condemn the steel. At first thought, the outlay of 60 to 80 cents a pound for steel did not appear out of proportion to the decreased cost of production, provided the tool did what was expected of it; but when it proved a failure then the cost of the steel, the increased cost of working it, and the time that Tom, Dick, Harry, and half a dozen others spent watching results were all taken into consideration, and as there was nothing to show in its favor it wouldn't have been a pleasant task for a representative of this form of steel to have happened in there to show his wares just then.

Now the advertising department of the house handling the steel may have been responsible in a measure for this. It is possible, and probable, that results equaling those claimed for the steel had been obtained when the tools were tried on dead soft stock, that was free from hard spots, etc.—the limit was obtained so far as speed was concerned. Now it is a fact that if you tell a man you will give him 10 per cent. more for his money than he can get anywhere else he is satisfied to buy of you and will advertise you and your goods to all his friends; but if you tell him you will give him 100 per cent. more and then he fails to realize this amount, he will be very loud in his condemnation of you and your goods. Should he stop and analyze the matter he might find he was a gainer of 75 per cent. by the transaction, but no, he was promised 100 per cent. gain and he has been defrauded.

Now the above seems to be the case with quite a number of manufacturers who have bought high speed steels. They expected big things, but when they attempted to get the limit advertised for the steel and failed they immediately condemned the steel and everybody who had ever mentioned it to them. They did not try speeds and feeds a little less than those claimed possible, to ascertain if they could not make a very material gain over the records held by carbon steel tools, and if 100 per cent. was not possible, try and get 75 or even 50 per cent. or less gain, and considering that even at that they were well repaid for adopting the new steel for such work as it was adapted for.

Another reason why better results are not obtained in many cases is because instructions are not always followed implicitly when working the steel. The different makes of this steel are not all worked alike and the treatment necessary to give one make does not give best results when applied to another. For this reason the instructions given should be very carefully noted and followed as closely as possible.

Some steel houses, knowing that the experience of the ordinary tool dresser does not qualify him to properly forge and harden tools made from their steel, send men around to instruct the tool dresser in the art as applied to their brand. Now in order to get good results it is necessary to send out a good man, and even he finds difficulty in making the average blacksmith believe he can heat a piece of steel to a dazzling white and not spoil it.

A few concerns have made the mistake of sending out a man who knew little or nothing of blacksmithing. He didn't know how to make a fire as it should be made; and he handled the hammer like an amateur, and succeeded in impressing the blacksmith with the fact that he didn't know his business and that there was little to learn from him.

Experience has taught me that when tools made from this steel are properly forged, and heated for hardening, better results are obtained if the tool is held several inches from the mouth of the air blast when cooling, rather than close to the outlet.

A great deal depends on the shape of the tool. It may be forged and hardened in a satisfactory manner and then rendered unfit for use by improper grinding. I have seen tools which could not be made to stand up at all, but when reground and given the proper shape, worked all right.

Then again results anything but satisfactory are obtained at times because we are given to understand that we can run our work at so many feet per minute when cutting machinery steel. Now the term machinery steel, as generally understood among mechanics, covers everything between wrought iron and tool steel. A tool that would stand up when machining a very soft piece of stock at a high rate of speed would go right down if we attempted to use it on a piece that was harder if we run the work at the same rate of speed. It is not every mechanic who will discriminate between a low grade of steel containing 10 points carbon and one containing 60 points, yet in order to get tools to stand up well it will be found necessary to run much slower when machining the higher carbon.

I remember an instance where some milling machine cutters were made from one of the leading brands of this steel, and were run at 120 feet per minute on 70-point carbon open hearth steel. The results were not all that the party had been led to believe he would get. They would not stand up sufficiently long between grindings to warrant the extra expense of the cutters.

It was suggested that the speed be reduced very materially, and this seemed advisable for various reasons. When running at the rate of speed mentioned it was not possible for the operator to tend to the machine promptly, and the cutters were cutting air for some seconds at the end of each cut, and it was found that the machine, which was not built for any such business, was tearing itself to pieces.

The speed was reduced to 65 feet per minute, which was more than double the speed of cutters made from carbon steel when used on this work, and the cutters stood up well and proved a very satisfactory investment. Now had the manufacturing concern let the matter drop where the cutters failed to stand up when run at 120 feet per minute, and pronounced the steel a failure, and the men selling it humbugs, as many do, they would have failed to reap the benefits they are getting from its use.

This steel can be purchased annealed soft enough to work into tools of any form, or it may be annealed in the shop provided the necessary facilities are at hand. What we require is a furnace where we can get a heat sufficiently high and that we can keep for the desired length of time.

Various methods are recommended for annealing. Some claim good results by packing the steel in boxes or tubes with charcoal; others advocate lime, and still others claim sea sand gives best results; but the writer has had best results when the steel was packed in dry fire clay in a box or tube. He has tried all the others, but none of them gave as good results as fire clay. The boxes—or tubes—were placed in a furnace and heated to a yellow heat, and kept at this heat for a much longer period than when annealing carbon steel, the length of time depending on the size of the piece and the nature of the steel. When they had been subjected to heat for a sufficient length of time they were allowed to cool very slowly, the slower the better.

When machining this steel after annealing it is advisable to use tools made from the same kind of steel, as we can work more rapidly than if we used ordinary tool steel. If the instruction just given is followed it can be machined as rapidly as carbon steels when carbon steel tools are used.

In order to harden this steel satisfactorily it is necessary to heat it very hot. Instructions sent out with the steel say it is not possible to heat it too hot. This is not so; I have seen milling machine cutters which were heated so hot the teeth were melted off, but it is necessary to heat very hot, to a dazzling white heat, as it is termed. If we are hardening lathe, planer, or similar tools they should be cooled in a strong air blast of generous proportions. However, when hardening milling machine cutters, taps, etc., dip in a bath of oil.

The method of heating depends of course on the facilities furnished by the individual shop. Lathe, planer, and similar tools which are to be ground may be heated in an open fire, but milling machine cutters, taps, etc., must not be heated and then exposed to the air, or they will scale to an extent that would make them useless. In some shops they are heated in a crucible of lead, which is made very hot. It is necessary to use a graphite crucible or one made of materials that will not melt when subjected to the high heats. If the work is to be heated in the lead crucible, it must first be placed in fire and heated to a red before putting into the lead, as the sudden expansion caused by putting the cold steel into the lead heated to the high heats would cause it to crack.

A furnace burning gas or oil which can be heated to the required heat furnishes a more satisfactory means of heating work of this character than the lead crucible, as the pieces can be inclosed and so removed from the action of the air. When heated in the furnace mentioned better results are obtained, as the lead sticks to the steel. The high heat forms dross very rapidly, and this sticking interferes somewhat with the action of the oil on the heated steel.

The results that have been obtained in some shops with high speed steel are indeed wonderful, and there is no doubt but that the steel has come to stay until something is produced that is better.

The one thing necessary is that when working and using, be very careful to follow instructions implicitly except in the case of speeds which are not always to be taken literally, and I think were the parties who sell the steel to go over the ground again and make a list of speeds at which it is advisable to run the material, they would modify their figures very materially in certain cases.

So don't take it for granted that because, on certain work, you cannot get 200 per cent. more speed out of it than you have been getting from regular tool steel it is of no use; be satisfied if you make a 50 per cent. gain, provided you can get no more; that would well pay for the investment.

USE OF DIAGRAMS AND TABLES FOR THE SOLUTION OF PROBLEMS IN GEARING.

FRANK B. KLEINHANS.

It is no small task to figure out the proper strength for every gear in a train, and this is especially true when the entire arrangement of the train is a new one and the designer has no former construction on which to base the design. Let us take, for instance, the arrangement of the gearing in the design of a new 120-inch lathe or of a large-size planing machine. We know to start with, the required pull which is necessary on the outer circumference of the faceplate of the lathe, or we know the force that will be required at the tools on the planer. The diameters of the various gears have not been settled upon, and therefore we do not know the pitch line velocity or the pitch line force. We are accordingly obliged to lay down a train of gearing which our judgment leads us to believe will be satisfactory, and then figure out the velocity, pull, etc., and finally investigate the gears for strength.

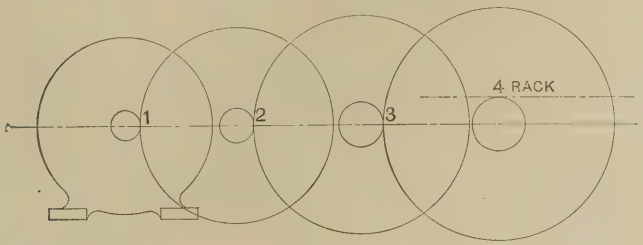


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Fig. 1.

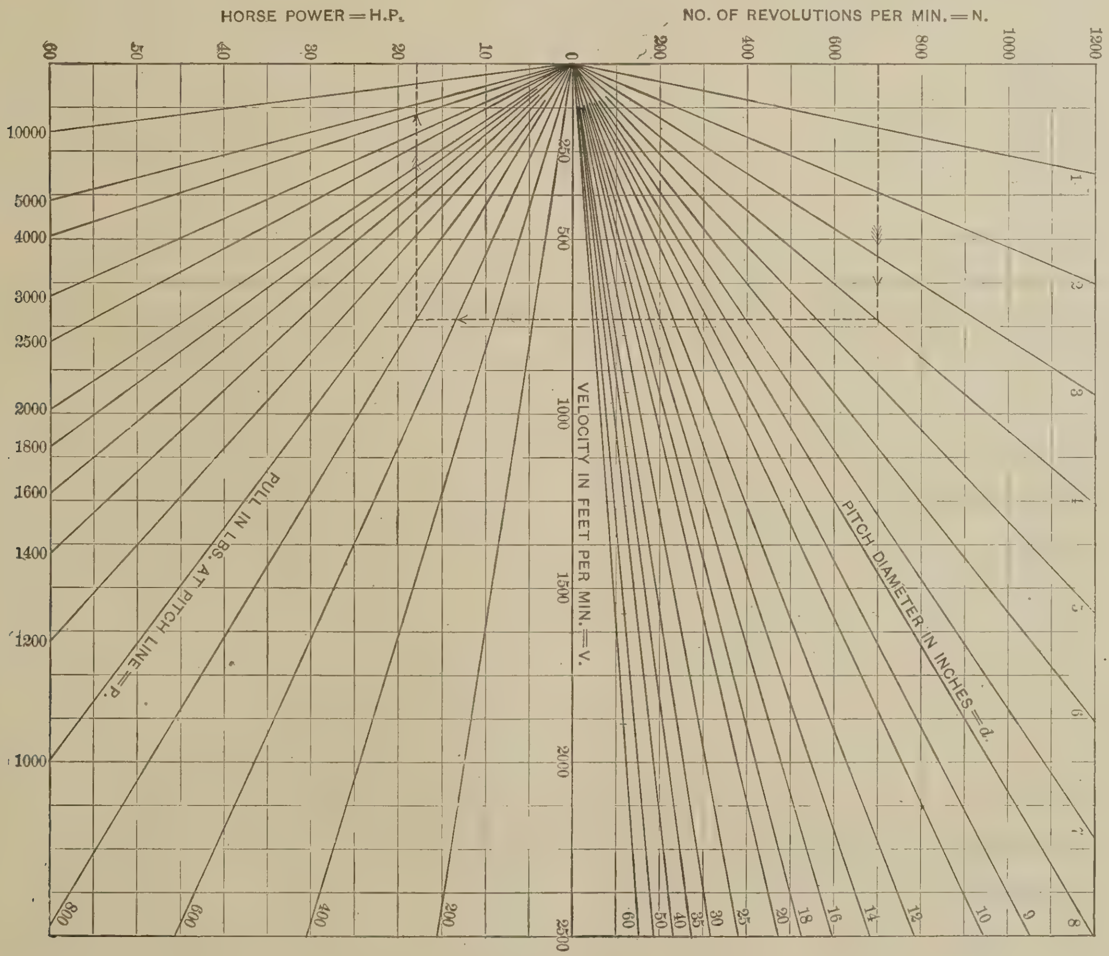

Fig. 2.

This requires a great deal of time and patience, and frequently the results which are arrived at for a train of gears are of no account, and are therefore cast aside and forgotten. In this article it is intended to show a systematic method of calculating these trains and noting the results in the form of a table. This not only makes the work much easier, but reduces the liability to error and gives us a record of everything that has been done. We frequently find that a certain arrangement of gearing which has been considered unsatisfactory, and the results of which have been cast away, will work well, and, with certain alterations, is just what is wanted for another case. If we have these calculations noted in the form of a table we can refer to them at any time, not only during the design of the machine, but a long time after the machine has been built, for there are ever coming up questions in regard to alterations in design, in order to meet new requirements, and these calculations are then very useful.

Let us suppose that we have an arrangement of gearing to work out which would be satisfactory for traversing a head of a double-end boring machine. The head weighs 19,840 pounds and, allowing a pull of 25 per cent. of this amount to overcome the friction, we would require a pull of 4,960 pounds. It is intended to traverse the head at a speed of 25 feet per minute. We must know about what the frictional losses are in order to figure out the size of motor that will be necessary for doing the work. We find that, including friction, a little less than 7 horse power will be required to do the work. The nearest commercial size of motor that would answer would probably be one of 10 horse power, and we will assume that this is the size that we will use.

The motor and the arrangement of gearing with the proper reduction is shown in Fig. 1, the figures 1, 2, 3, etc., applying to the pair of wheels which are in contact at these places. In Table 1 we arrange the number of gears in the train, along the top line; then following on down the left-hand column, the number of revolutions of the pinion, velocity in feet per minute at the pitch line, the separate efficiency which applies to the pinion and its shaft, and then the logarithm of the combined efficiency. From this logarithm we can obtain the necessary pull that will be required at the pitch line of the motor pinion in order to overcome the friction and perform the work. From these logarithms the pounds pull at the pitch line is obtained, and knowing this, and referring to our table for the strength of the gear teeth, we pick out a pinion with face to conform if possible with the patterns which we have on hand. A cast iron pinion having 20 teeth, 5 pitch and 2¼-inch face will stand an actual pull of 400 pounds, so all of these things are noted down in the table.

We then find in the next column for the gears marked 2, that the actual pull to suit the conditions of the pattern will be 930 pounds. The gear marked 3 will have a strength of 2,550 pounds; and gear 4 will have a strength of 11,000 pounds. Thus we can see by referring to the table just how much stronger the gears are than is actually required. Of course all of this calculation would be for the weakest member, which in this case will be the pinion. If we had a steel pinion engaging with a cast iron gear we would then have a set of figures for the pinion and another for the gears.

As all of the tables for the strength of gearing require us to know the velocity in feet per minute and the pull at the pitch line, the diagram shown in Fig. 2 has been arranged so that one can readily pick out any of the following specifications:

Number of revolutions.
Pitch diameter in inches.
Velocity in feet per minute.
Pull at the pitch line.
Horse power.

As an example, suppose we have a case where

$N = 700$ revolutions per minute.
$d = 4$ inches,
pull at pitch line $= 800$ pounds.

From the diagram we find that the motor required will be a little less than 18 horse power, as shown by the dotted line, and that for this case $V = 730$. We are thus able to pick out from the table without any calculation, the revolutions, diameter, velocity and actual pull as noted in Table 1.

TABLE I. CALCULATIONS OF GEAR TRAIN SHOWN IN FIG. 1.

No. of Wheel in Train.	1	2	3	4
Revolutions per minute.	900	300	100	25
Diameters, inches.	4 12	5 15	6 24	7
Velocity, feet per minute	940	390	160	45
Theoretical Pull in pounds	350	840	2100	7300
Separate Efficiency	.96	.95	.92	.80
Log. of Combined Efficiency	9.9823—10	9.9600—10	9.9238—10	9.8269—10
Pull in pounds required	365	920	2510	10900
Pull for which Gear is suited	400	930	2550	11000
Diametral Pitch	5	4	3	2
Teeth	20	20	18	14
Face, inches	2¼	2¾	4¼	4
Material	Cast iron	Cast iron	Cast iron	Forged steel

Let us take another case, shown in Fig. 3, where it is desired to use a motor in order to elevate the cross rail of a planer. The elements of the different parts are marked 1, 2 and 3, the latter being screws. We again arrange our table and in it note the numbers for the different parts of our train. The gears marked 2 are existing gears on the machine, as are also the screws 3. The cross rail weighs 6,000 pounds and is to be elevated at a speed of 12 feet per minute by means of the screw, which has a ½-inch pitch, double thread.

TABLE II. CALCULATIONS OF GEAR TRAIN SHOWN IN FIG. 3.

No. of Wheel in Train	1	2	3
Revolutions per minute	1200	400	240
Diameter, inches	4 12	4½ 7½	1¾
Velocity, feet per minute	1260	470	90 feet neutral line
Theoretical Pull in pounds	48	128	6000
Separate Efficiency	.97	.968	.408
Log. of Combined Efficiency.	9.5834—10	9.5966—10	9.6107—10
Pull in pounds required	125	324	14700
Pull for which Gear is suited	150	500	Two 1¾″ screws
Diametral Pitch	Chain	5	2
Teeth	"	22 37	Screw
Face	"	2	"
Material	"	Cast iron	Machine steel

From the tables of Weisbach and Herman we find that the efficiency of a screw of this description is .408. The efficiency of train 1, from experiments under similar conditions, is known to be .97, and that of train 2 is .968. We then determine the horse power necessary for the work as follows:

$$H\ P = \frac{6{,}000 \times 12}{33{,}000 \times .384} = 5.68,$$

or, say 6 horse power.

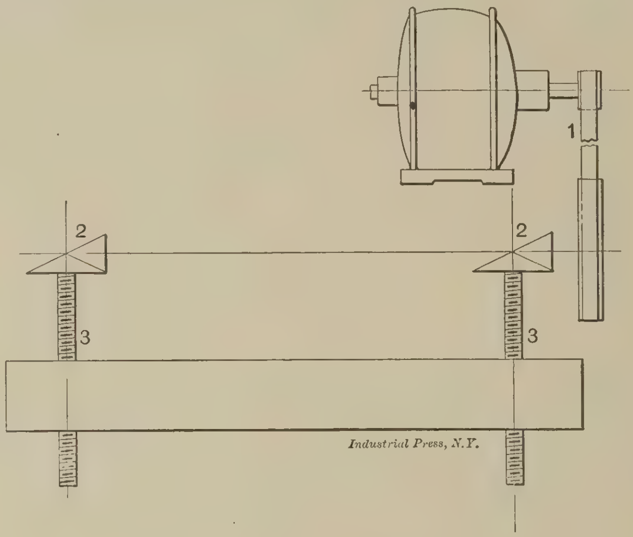

Fig. 3.

The velocity, pull, etc., are obtained from the chart and the gears picked out which will stand as much, or a little more than the required pull. One thing will be noticed in the last example: The actual pull is very much greater than the theoretical pull, and this is due to the enormous frictional losses in the screw. In taking up a new design we should sketch out the arrangement of the gearing and then arrange the data as shown in Tables 1 and 2.

* * *

SUPERHEATED STEAM.*

A REVIEW OF ITS DEVELOPMENT AND USE.

The use of superheated steam is not new; on the contrary, it is probably not far from 75 years old. The old masters in steam engineering, without doubt, realized the fact that the principal loss of efficiency in the steam engine was due to the condensation of steam in the cylinders, and, as is well known, they tried a great many means to reduce it, and with varying degrees of success. There is no question in the minds of all competent authorities that the best means of reducing the condensation is in the use of highly superheated steam, and this has been known for a great many years. It almost seems that the "grand old man," James Watt, anticipated or at least had a presentiment of nearly all the improvements in the steam engine which were to be introduced into its design during the last century. However, it appears he had no knowledge of superheated steam or of its advantages, which seems very natural, as he really was the first one who had an adequate and thorough knowledge of saturated steam. The first mention of the practical use of superheated steam which I have been able to discover, is found in the "Life of Richard Trevethick" of the Binner-Downs Mine in Cornwall, England. In this book it is stated that a certain Captain McGregor in 1828, in order to compete with a record established by an engine of a neighboring mine, whose cylinders had been insulated with sawdust, built a jacket of brick around the cylinder and the steam pipe, with an air space between the brick work and the iron and that he built a fire in this open space, by which means he increased the duty of his engine from 41,000,000 to 63,000,000 foot-pounds per bushel (86 pounds) of coal. Trevethick himself tested the 70-inch cylinder engine with steam at 48 pounds pressure and which made 8 strokes per minute, and he found that by using 5 bushels of coal in 24 hours under the cylinder, he reduced the consumption of coal by the boiler from 108 to 67 bushels for the same work, showing a saving of more than 26 per cent. That such a saving must necessarily have aroused attention is evident; but it has been impossible for me to find any trace of it in the published records. In 1834 John Ericsson made some experiments with superheated steam, but no record of these experiments have been found. The next record that I have been able to find is that in 1845 Mr. Longridge made several experiments with superheated steam at low pressure, and in 1851, he was followed by Rafford in France who took out patents for a superheating plant.

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* From paper by Prof. Storm Bull, Journal of the Western Society of Engineers December, 1903.

From this time on, and lasting, perhaps, for 20 years, the interest in superheated steam was very active. Among the many engineers and scientists who contributed to the progress in this line should be mentioned especially Hirn, Isherwood and Faraday. The first named made a great many experiments in 1857, using steam of 55 pounds pressure and temperatures from 410 to 490 degrees Fahrenheit. The results of his accurate experiments showed an increase in the economy of the whole plant of from 20 to 27 per cent.

During the fifties and sixties, however, the principal use of superheated steam was found in the marine engine, and in the literature of the subject quite a number of tests of steamships with and without the use of superheated steam may be found. Penn showed an increase of economy of 20 per cent. for the steamer *Valletta* with a steam pressure of 20 pounds. The Parson and Pilgrim's superheater was especially designed for marine practice. It consisted of a number of semicircular pipes placed in the furnace, by which means it is stated that a saving of one-third in fuel was realized. The English Board of Trade, however, objected to the use of superheated steam on the ground that the high temperatures used were liable to break the steam up into its elements, thereby making it unnecessarily dangerous. Fortunately, Professor Faraday, who fully investigated the matter was able to convince the authorities that this objection was unfounded. The test of marine engines made at about the same time, during the latter part of the fifties, show gains in economy of from 20 to 30 per cent., always depending upon the amount of superheat which was available.

Our own Isherwood was at first very skeptical as to the practical use of superheated steam. He at first declared against it on the ground of injury to the cylinder, difficulty of lubrication, extra weight and short life on board of ship. Later on, however, he recommends the use of superheated steam because of the gain in economy of 30 per cent. shown by his experiments, but suggests that the limit of superheat be placed at 100 degrees Fahrenheit, on account of the difficulties of lubrication. In 1863-1864, he made extensive tests on the steamer *Eutaw* which had, a single, cylinder inclined engine with poppet valves and a Stevens adjustable cut-off. The best results of these tests show a gain in steam economy of 18 per cent. and 15 per cent. in coal consumption.

During the years from 1850 to 1870 a great many superheaters were installed, especially on shipboard, notwithstanding the fact that engineers always found great difficulties with respect to the lubrication and that the material of the superheaters did not withstand the action of the heat for a very long time. That there was trouble with the lubrication should not surprise anyone when it is remembered that none of our present-day mineral oils were known at the time, and that the only available lubricating materials were animal oils and fats. The steam pressure used up to that time did not exceed 50 pounds, at least not on shipboard, and for such a pressure the animal oils or tallow answered very well, even if the steam was superheated perhaps 100 degrees Fahrenheit. But the latter part of the sixties saw the introduction of the compound engine with its accompanying high pressure, and this proved to be a very effective damper to the use of superheated steam—and for two reasons. The first one was the very much greater economy of the compound engine as compared with the single expansion engine using steam of lower pressure, and because of this increased economy a saving of both space and weight, a very important factor in a ship. The second reason was that the difficulties in the way of proper lubrication of the cylinders became so great that it was found necessary to reduce the superheat to such an extent that the gain from it in economy became almost imaginary and this certainly did not warrant the expense of the installation of the superheater. The universal use of the compound engine on shipboard, therefore, very soon made the use of superheated steam impossible on steamships. It had been much less used in stationary practice, but with the gradually increasing pressure it also disappeared here. It is true enough that the use of mineral oils very soon after this time became general, but our present day heavy lubricating cylinder oils were not known then and in, addition—and this is much more important—the attention of all the foremost engineers of the world, working in this line, was now exclusively directed toward the improvement of the economy of the steam engine by means of the use of higher pressure and of the compound principle; they lost sight of the superheated steam, presumably, because of the many bad reports regarding its use. You all are aware of the fact that the improvement of the economy of the steam engine during the last thirty years of the last century was all due to the increasingly higher steam pressure and to the introduction of the compound and multiple expansion engines, if exception be made concerning the greatly improved mechanical details, especially with respect to valve gear and governor. But toward the end of the last century nearly all competent engineers agreed that the improvement due to the causes just mentioned had about reached its limit. The increased cost of making more than a triple or quadruple engine was not warranted by the very slight increase in economy due to an additional cylinder—at least with the high steam pressure then practicable. Because of the available material it had been impracticable—perhaps unprofitable—to design boilers for a higher pressure than, say, 250 pounds. It is due to this fact that the attention of the engineering world has within the last half dozen years increasingly been directed to the use of superheated steam as a means of improving the still lamentably low economy of the steam engine, and it is my opinion that the history of these years has conclusively shown that for the present, at least, the outlook in this direction is very much brighter than in any other.

Recent Developments in Superheated Steam.

In recent years the development of apparatus for superheated steam has been more marked abroad than here and among its most prominent advocates have been Hirn, in Mulhouse, Schwoerer, his successor, and William Schmidt, in Germany, who was the first to use in practice highly superheated steam. You will doubtless remember the sensation that was created some eight years ago, when the results of tests on a boiler and engine constructed by William Schmidt were reported in the technical papers. Although the engine was quite a small one, yet it was shown that the consumption of steam was only about 10.4 pounds per indicated horse power per hour, when using superheated steam. The statement of the consumption by an engine of a certain number of pounds of superheated steam per horse power per hour does not give the means for a true comparison of the performance of this engine with one using saturated steam. It is much more equitable to base the comparison on the consumption of coal or the number of heat units converted into work. In the test spoken of it was shown that the amount of coal used per indicated horse power per hour was only about 1.3 pounds, certainly an extraordinary result for an engine of only 75 horse power. The engine in question was a tandem compound, both cylinders being single acting; of very original design throughout and built especially for the use of highly superheated steam. The boiler, which was also built and designed by Mr. Schmidt, was also very original and has since proved to be excellent in every way. As a result of this first test, Mr. Schmidt's engines became very popular and at the present time several hundred are running in Germany and adjacent countries.

As is well known there are two essentially different arrangements of the superheater with respect to the boiler. The most common is to install a coil in the boiler setting proper, through which the saturated steam taken from the top of the boiler is drawn on its way to the steam engine. If a high degree of superheat is wanted the coils must be installed in such a way that the hot gases will strike them long before they have been cooled sufficiently to allow them to escape into the chimney. This arrangement has, as is well known, been extensively employed by the Babcock & Wilcox Company. On the other hand, if only a slight superheat is desired the coils may be placed so that the gases on their way from the boiler to the chimney will surround the coils. This last arrangement is usually not satisfactory, as the degree of superheat is so small that the gain in economy of the steam engine frequently does not warrant the installation of the superheater.

The second arrangement is to install an independent superheater with separate furnace, and a great many installations of this kind are found at present, especially on the continent of Europe. Many competent engineers have expressed their doubts as to the possibility of a gain in economy due to such installations, but repeated tests of a number of such plants have shown that these doubts were not warranted by the facts.

Both wrought iron or steel, and cast iron are used for superheaters. Because of the high temperature to which the material of the superheater will be raised, it is impracticable to have ordinary flange joints or couplings exposed to the hot gases. If therefore the superheater consists of a series of steel pipes of small diameter, they must be bent into coils, something like the ammonia pipes in a refrigerating machine. If on the other hand, the superheater is built of cast iron, there are usually a number of large, straight cast iron pipes connected by flanged return bends, the flanges being placed in such a manner that they cannot be reached by the hot gases, these pipes being also provided with a large number of external ribs so as to increase the heating surface.

The difficulties which were encountered years ago with respect to the wearing out of the superheaters have now been overcome, as can be readily seen from the fact that there are now in service superheaters which have been used continuously for eight years and without any important repairs. The number of plants now running in continental Europe is several thousand, of which several hundred are more than four years old.

It was also to be expected that the use of such high temperatures in the engine cylinder would create new difficulties, not alone with reference to the proper lubrication of the same, but also and perhaps still more so, with regard to the great expansion of the parts of the cylinder itself. But it can also be stated that all these difficulties have been overcome. Just as in the gas engine where the temperatures are very much higher, and where these difficulties have been overcome by the proper design of the cylinder, so in the steam engine our modern engineers have found the proper way to proportion the various parts of the cylinder in such a manner that the expansion due to the high temperature does neither produce breaks in the casting nor leaks at the stuffing boxes. With reference to the lubrication it is only necessary to refer to our modern heavy lubricating oils which made our modern gas engines possible. The latest type of engine designed for superheated steam does not look very different from an engine using saturated steam of very high pressure, although a good many details may be different. The experience of recent years is that Corliss valves are not adapted for the use of highly superheated steam and that consequently we will have to modify the design of our most economical engines in a very essential part before we can use with profit, steam superheated to a degree which will show an improvement in economy to a degree that will warrant its use.

Superheated Steam Engine Tests.

The principal results of the test of Prof. Schroeter of the Schmidt engine and boiler in 1895 and mentioned before, were as follows:

TABLE I.

Size of Engine—12¼ in. x 27$\frac{3}{16}$ in. x 19½ in.; vertical, tandem, compound, making—

	1st Test.	2d Test.
Pressure	156.2	159.0
Brake Horse Power	61.72	62.18
Superheat, Degrees Fahrenheit	235.0	281.0
Steam in Lbs., per I. H. P., per hour	10.91	10.19
Steam in Lbs., per Brake H. P., per hour	12.61	12.34
Coal in Lbs., per I. H. P., per hour	1.36	1.26
Coal in Lbs., per Brake H. P., per hour	1.57	1.52
Per Cent of Heat Accounted for in Saturated Steam	65.0	63.7
Per Cent. of Heat in the Superheat	6.9	8.2
Per Cent. of Heat given to Feed Water	6.9	6.6
	78.38	78.5

In 1896 Professor Ripper of England published the result of a series of tests of a small Schmidt engine using superheated steam. The size of the engine was 7 1-16 by 11¾; it made 180 revolutions per minute. He used both saturated steam, and steam of different degrees of superheat in order to show the influence of the same.

TABLE II.

	1	2	3	4
Steam Pressure, Lbs. Absolute	87.5	79.9	87.6	116.0
Temperature of Steam, Deg. F.	329.0	412.0	667.0	653.0
Degrees of Superheat, F.	0.0	88.0	338.0	306.0
Indicated Horse Power	16.55	16.32	16.59	17.60
Lbs. of Steam per hour per Indicated Horse Power	39.33	34.66	19.13	17.58

It will be apparent from this table how rapidly the consumption of steam decreases with the increase of the superheat. With 338 degrees of superheat the number of pounds of steam used is not quite one-half that used for saturated steam. In itself this performance of a single-expansion, non-condensing engine, indicating only some 18 horse power and using less than 20 pounds of steam per horse power per hour is very startling.

A small Schmidt steam engine and boiler installed at Ascherleben, Germany, was tested by Professor Schroeter. The cylinder had a diameter of 9⅞ inches and a stroke of 15¾ inches and was single acting; it made 150 revolutions per minute. A series of tests was made to show the influence of the cut-off and of various degrees of superheat. The most important results were as follows:

TABLE III.

	1	2	3	4	5
Cut-off, Per Cent	16.1	22.9	35.0	41.1	48.0
Steam Pressure, by Gage.	120.0	115.7	111.4	98.7	95.8
Temperature, Deg. F	669.0	671.0	673.0	680.0	689.0
Superheat, Deg. F.	319.0	324.0	328.0	343.0	354.0
Consumption of Steam per Horse Power per hour	17.85	17.59	18.03	17.54	18.03

The results show that the cut-off has very much less influence on the economy of the steam engine when running with superheated steam than with saturated, because there is very little change in economy between a cut-off of 16 per cent. and one of 48 per cent., whereas it is probable that if the engine had been running with saturated steam this difference would probably have been at least 25 per cent. It is also well known that the interchange of heat between the steam and the cylinder walls is very rapidly reduced with increased superheat, so that, for instance, the heat absorbed by the walls during the admission period is almost zero when the steam is superheated from three to four hundred degrees. The gain in economy due to the use of superheated steam is not alone due to the greatly reduced condensation in the cylinder, but also and perhaps in just as high a degree, to the greatly reduced interchange of heat between the walls of the cylinder and the steam while it

TABLE IV.

Number of Test	1	2	3	4	5	6 (empty)	7	8	9	10	11	12	13	14	15	16
Indicated Horse Power Developed	316	277	222	170	118	22	318	272	223	170	121	226	227	223	223	218
Degrees of Superheat	......	......	......	......	......	....	204.4	225.2	225.9	223.9	223.9	43.7	97.7	151.7	221.2	310.9
Consumption of Steam in Pounds per H. P. Indicated	13.43	12.64	12.08	11.48	11.84	13.52	10.71	10.25	9.83	9.59	9.50	11.58	11.00	10.67	9.81	8.89
Gain in Economy on the Basis of Actual Consumption of Steam	......	......	......	......	......	....	....	....	......	....	....	.04	.09	.12	.19	.26
Equivalent Consumption of Steam per H. P. Indicated	......	......	......	......	......	....	11.64	11.18	10.74	10.43	10.36	11.77	11.44	11.33	10.69	10.01
Gain in Economy due to Superheating, based upon Equivalent Consumption	......	......	......	......	......	....	.133	.121	.110	.104	.125	.024	.051	.060	.113	.174
Heat Units Required per I. H. P. per hour	278	261	250	241	245	280	241	231	222	216	214	244	237	234	221	207

is in the superheated state, this being due to the absence of water, which is always adhering to the walls when saturated steam is being used. From a number of carefully conducted tests it has been shown that the steam at the end of the expansion in the high pressure cylinder of a compound engine is still slightly superheated, if the superheat to begin with is from 200 to 300 degrees Fahrenheit.

A month ago appeared a series of articles in the *Zeitschrift des Vereins Deutcher Ingenieure* by Prof. Schroeter, in which he gives the results of some remarkably interesting tests of a 250 horse power, compound steam engine, built and installed in Ghent, Belgium. The tests were made to determine the economy due to superheating the steam to various degrees and also to determine the influence of variation of load on the economy, using superheated steam. The results obtained from this engine are truly remarkable and in fact are so good that Prof. Schroeter says in the first article that the economy is higher than for any other engine of its size so far tested. A series of six tests with saturated steam and different loads was first made, then five tests with superheated steam, and for the same loads, with the exception of one, in which the engine was empty, and finally five tests were made for the same load but with different degrees of superheat.

The engine was a tandem compound, having poppet valves and ran-condensing. The cylinders were 12¾ inches and 22 inches in diameter, the stroke being 32½ inches, and it made 127 revolutions per minute. The steam pressure was kept as nearly as possible equal to 145 pounds by the gage during all the tests. The main results are given in Table IV.

By equivalent consumption of steam is meant the reduction of the number of pounds of superheated steam used to the equivalent number of pounds of saturated steam of the same pressure, the reduction being made on the basis of heat units contained. The comparison of economy on this basis is consequently, perfectly equitable. The results as will be seen, are certainly startling, as I do not know of any engine of this size which has as high an economy whether running with saturated or superheated steam, the best results being 11.48 pounds for saturated and 10.01 (equivalent) for superheated steam. It is also shown in the article mentioned that in several of the tests the steam was still superheated, both at the end of admission and of expansion, confirming the general statements in this respect made before in this paper.

* * *

LARGE FIRE PUMPING STATION FOR PHILADELPHIA.

The desirability of providing separate mains for domestic water supply and for fire service has long been evident to those interested in fire insurance matters. The existence of two systems of mains not only greatly diminishes the possibility of a failure of the water supply, but very often makes it possible to carry a pressure sufficient for fire protection without the need of fire engines. This is of special importance in crowded districts where fire engines are frequently subject to delay and often prove inadequate in fighting fire in modern high office buildings. While it would be possible to carry a high pressure in the regular service mains, it is entirely impracticable, not only because of the extra expense of pumping all the water at high pressure, but also the increased leakage and cost of fittings, loss of pressure, etc. Where a high pressure is maintained in separate fire mains, the individual fire protection systems of buildings may be so connected that water is always available on any floor of the tallest building.

However, it is not always advisable to maintain such a service from a municipal water-works plant, often because the distance through which it would be necessary to carry the high pressure mains would be unnecessarily great, and moreover an accident to the plant might disable both services. The high pressure pumping engine would probably be of a type different from the regular service engines, and little economy would be gained by placing them in the same station, further than a possible saving in attendance.

Many considerations favor locating the fire pumping station directly in the heart of the district to be protected. The character of the motive power then becomes the next consideration. If steam is used, it will be necessary to keep steam up in the boilers continuously, although the plant may be called into action only once or twice during a year. Electricity has also been proposed, and it might be advisable where connection could be had with a number of independent electric supply circuits, thus minimizing the chances of shut-down. One of the latest plants of this character has recently been completed in Philadelphia, where it is located on the Delaware River water front, at the corner of Race Street and Delaware Avenue. In place of electricity or steam, however, gas has been chosen for the motive power and Westinghouse gas engines have been installed, the fuel supply being taken from the city illuminating gas mains. The pumping station, which occupies a building 72 by 140 feet, will contain ten 11½ by 12-inch vertical, direct-acting Deane triplex pumps, each capable of delivering 1,200 gallons per minute at 40 revolutions, against a pressure of 300 pounds per square inch. There are also two 6¼ by 12-inch pumps of the same type of 350 gallons capacity per minute. These pumps are to work together or singly, as may be desired, and all will discharge into a common 20-inch main. The water supply for the pumps will be taken directly from the Delaware River through a 36-inch suction main. Only seven of the larger pumps are being installed at present. Each of the pumps will be driven by a separate engine. The smaller engines will be direct-connected to the smaller pumps through friction clutches and will also drive electric ignition generators of 7.5 kilowatts each and the air compressors supplying air at 200 pounds pressure for starting the main engines. There are three sources of current for ignition, connections with the city lighting mains and a storage battery being provided in addition to the ignition generators.

Triplex pumps have been selected because of the even flow of the discharge, producing practically constant pressure on the discharge mains and making a very even load through all parts of the gas-engine cycle. The crank shafts are driven from the engine shafts through single-reduction gears. The fact that the pumps are of the vertical type makes it very easy to connect the pumps directly to the engines and also results in a considerable saving in space.

Each pump is fitted with a by-pass valve and a relief valve, the manner of using these valves being well described in the following clause from the specifications:

"It is proposed to maintain about sixty (60) pounds pressure on the fire mains from the city reservoir. The pumps will be started under these conditions with the by-pass open, and any surplus of water pumped will be discharged through the relief valve into the suction main. When the engine is under way the by-pass will be closed and when the water is used as fast as this unit will deliver it, its relief valve will close. In the meantime a second unit will be started and handled in the same way and so on until the full plant is in operation."

The pressure in the fire mains is controlled automatically by an electric motor acting on a valve. It may be held steadily at any point under 300 pounds while a spring relief valve prevents it from rising above that amount. The water ends of pumps are divided into sections, that is, each cylinder and valve chest is a separate casting and can easily be removed by itself without disturbing the other parts of the machine. This makes a convenient arrangement in case repairs are ever required for the water-end parts. The machines were especially dsigned for fire service by the Deane Steam Pump Company, of Holyoke, Mass., and are brass fitted throughout in order that they may be able to start after long periods of idleness.

The mains supplied by this pumping station are nine miles long and consist of pipes of 8, 12 and 16 inches diameter. They are of extra thickness and all fittings, including fire plugs, are of special design. The station replaces with advantage more than 40 fire engines, and as a result of its installation the rate of insurance will be reduced 25 cents per $100.

The selection of gas engines for motive power is novel, but is believed to be justified in view of the perfection of the modern gas engine as regards reliability and freedom from break-down. The great advantage incident to the use of gas engines is their economy during periods of idleness, as compared with steam plants and the a,bility to start up immediately and at full power.

NOTES ON DESIGN.—1.

MACHINERY SHAFTING.

C. F. BLAKE.

At first thought it seems as if an article upon this subject should be prefaced with an apology. Undoubtedly shafting has been the subject of as much discussion as any thing mechanical, and the rules laid down for mill shafting are so well founded as to be available under all circumstances, and so widely known as to require no discussion. When it comes to machinery shafts, however, we have the ordinary rules for twisting and bending moments, and for the two combined, but we often find complicated combinations of loading needing investigation, and we find little or nothing in the text books about the present practice followed in fitting up machinery shafting.

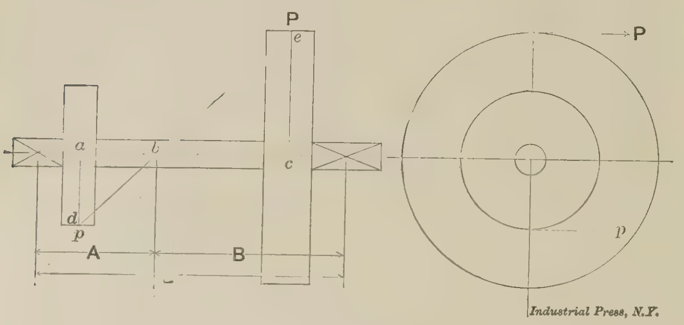


Fig. 1.

d	0	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	d
1	.196	.237	.279	.331	.383	.446	.510	.586	.663	.752	.842	.945	1.05	1.18	1.29	1.43	1
2	1.57	1.72	1.88	2.05	2.23	2.44	2.63	2.85	3.07	3.31	3.55	3.81	4.08	4.37	4.66	4.98	2
3	5.30	5.63	5.99	6.36	6.74	7.14	7.55	7.98	8.42	8.88	9.35	9.80	10.35	10.88	11.42	11.99	3
4	12.57	13.17	13.78	14.42	15.07	15.70	16.44	17.66	17.89	18.66	19.43	20.23	21.04	21.89	22.75	23.64	4
5	24.54	25.48	26.43	27.42	28.41	29.45	30.49	31.58	32.67	34.76	34.95	36.14	37.33	38.57	39.82	41.11	5
6	42.41	43.76	45.12	46.53	47.94	49.40	50.87	52.39	53.92	55.50	57.09	58.74	60.39	62.09	63.80	65.57	6
7	67.35	69.18	71.02	72.92	74.82	76.79	78.76	80.79	82.83	84.94	87.05	89.22	91.40	93.64	95.89	98.19	7

Table 1. Values of $\frac{T}{f} = \frac{\pi}{16} d^3$

In discussing the subject let us first take up briefly the three general principles governing shafting; simple twisting moments, simple bending moments, and combined twisting and bending moments.

When there is no bending moment the shaft may be designed for a simple twisting moment, and we have:

$$T = \frac{\pi}{16} d^3 f;\ d = \sqrt[3]{\frac{T}{.196\, f}} \ \ldots\ldots\ldots\ldots (1)$$

d	0	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	d
1	0.1	.119	.142	.167	.195	.222	.259	.297	.337	.381	.429	.480	.536	.595	.659	.745	1
2	0.8	.874	.959	1.04	1.14	1.23	1.34	1.45	1.56	1.68	1.80	1.94	2.08	2.22	2.37	2.57	2
3	2.7	2.86	3.05	3.24	3.43	3.63	3.84	4.06	4.28	4.52	4.76	5.01	5.27	5.54	5.12	6.17	3
4	6.4	6.69	7.02	7.34	7.67	8.02	8.37	8.73	9.11	9.49	9.89	11.29	10.72	11.14	11.58	12.15	4
5	12.5	12.95	13.46	13.95	14.47	14.98	15.53	16.07	16.63	17.20	17.79	18.39	19.01	19.63	20.27	21.09	5
6	21.6	22.25	22.97	23.68	24.41	25.14	25.91	26.67	27.46	28.25	29.07	29.90	30.75	31.61	32.49	33.61	6
7	34.3	35.19	36.17	37.12	38.1	39.09	40.11	41.13	42.18	43.24	44.33	45.42	46.55	47.67	48.84	50.30	7

Table 2. Values of $\frac{d^3}{10}$

in which $T =$ the twisting moment in inch-pounds,
$d =$ the diameter of the shaft,
$f =$ the fiber stress in pounds per square inch.

Table 1 gives the value of $\frac{\pi}{16} d$ for different diameters of shaft, and $\frac{T}{f} =$ constant in table.

Example: A shaft is to sustain a twisting moment of 120,000 inch-pounds, the fiber stress being 16,000 pounds per square inch, required the diameter of the shaft.

$$\frac{120{,}000}{16{,}000} = 7.5$$

The nearest constant in the table *above* 7.5 is 7.55, the diameter corresponding to which is $3\frac{3}{8}$ inches, which is the diameter of the required shaft.

A form of shafting frequently found in machinery is the stationary shaft, upon which certain heavy parts revolve, the shaft remaining stationary in the bearings, while the revolving pieces are usually brass bushed. Such shafts are often called pins, and being required to transmit no twisting moment, may be proportioned for a simple bending moment. Equating the bending moment to the moment of resistance for a round section we have,

$$M = \frac{\pi}{32} d^3 f = .098\, d^3 f$$

$$\frac{M}{f} = \frac{d^3}{10} \text{ very nearly.}$$

Table 2 gives values of $\frac{d^3}{10}$ for various diameters of shafts.

Example: A pin is to take a bending moment of 65,000 inch-pounds at 16,000 pounds per square inch fiber stress, required diameter of the pin.

$$\frac{65{,}000}{16{,}000} = 4.06$$

The nearest constant to 4.06 in the table is 4.06, the corresponding diameter being 3 7-16 inches.

When a revolving shaft through which power is transmitted, carries gears, drums or other devices, it is subject to both bending and twisting moments, and a calculation by either of the above tables ignoring the other will result in a weak shaft. We may, however, substitute for the simple twisting moment T a greater twisting moment T_e, which will be the equivalent of the combined twisting moment T, and bending moment M.

This equivalent twisting moment is

$$T_e = M + \sqrt{M^2 + T^2}$$

The diameter of shaft suitable for the combined moments T and M, may be found by substituting T_e for T in equation (1). This formula may be more conveniently used in the following form: Letting the ratio

$$\frac{M}{T} = k,$$

and letting,

$$D = nd,$$

where $D =$ the diameter of shaft for combined moments T and M, $d =$ the diameter of shaft for simple twisting moment T,

$$n = \sqrt[3]{k + \sqrt{k^2 + 1}} = \sqrt[3]{1.83\, k + 0.83} \text{ approximately.}$$

Table 3 gives values of n for various values of k.

Example: Suppose the shafts of the two previous examples are one, that is a shaft subjected to a twisting moment of 120,000 inch-pounds, and a bending moment of 65,000 inch-pounds, required the diameter of the shaft, with the fiber stress at 16,000 pounds per square inch as before.

$$k = \frac{65,000}{120,000} = 0.54$$

The corresponding value of n is 1.17.

k	n	k	n	k	n
.1	1.03	1.1	1.37	2.1	1.64
.2	1.06	1.2	1.40	2.2	1.66
.3	1.10	1.3	1.43	2.3	1.68
.4	1.13	1.4	1.46	2.4	1.71
.5	1.17	1.5	1.48	2.5	1.73
.6	1.20	1.6	1.51	2.6	1.75
.7	1.24	1.7	1.54	2.7	1.77
.8	1.27	1.8	1.56	2.8	1.79
.9	1.30	1.9	1.59	2.9	1.81
1.0	1 34	2.0	1.61	3.0	1.83

Table 3. Values of n for Various Values of k.

The diameter d for a twisting moment of 120,000 inch-pounds found in the first example is 3⅜ inches.

$D = 3.375 \times 1.17 = 3.94$ inches, say a 4-inch shaft.

A comparison of the three examples will show the importance of considering both the bending and twisting moments upon any shaft that is subject to both actions.

Another case of combined strains is shown in Fig. 2, where a gear under load P drives two pinions each under load p. First consider case A where all loads are in the same direction. Draw the bending moment diagram *b-b-b* for load P, also the diagram *a-a-a-a* for loads p. It is obvious, since the loads are on opposite sides of the bearing, that the bending moments will oppose each other, and the shaded portion of the diagram represents the algebraic sum of the two moment diagrams. Any ordinate of the shaded portion is the bending moment of the corresponding point of the shaft.

In case B the loads are not in the same direction. To find the moment at any given point on the shaft it is necessary to lay off separately, in the direction of each force, the bending moment ordinate for that force, as $MP = eb$, and $Mp = ba$, and take the resultant MR as the bending moment at the given point. This method may be extended to all forms of loading, as illustrated in the following examples:

Example: A shaft, Fig. 3, carrying a gear loaded to 2,140 pounds tooth load drives two pinions, each under 1,925 pounds tooth load, required the size of the shaft suitable for the given dimensions, the fiber stress being 9,000 pounds per square inch.

$$T = 1,925 \times 3.6 = 6,930 \text{ inch-pounds,}$$

$$Mp = 1,925 \times 4 = 7,700 \text{ inch-pounds,}$$

$$MP = \frac{2,140 \times 93 \times 4}{97} = 8,200 \text{ inch-pounds,}$$

$$MR = 11,248 \text{ inch-pounds.}$$

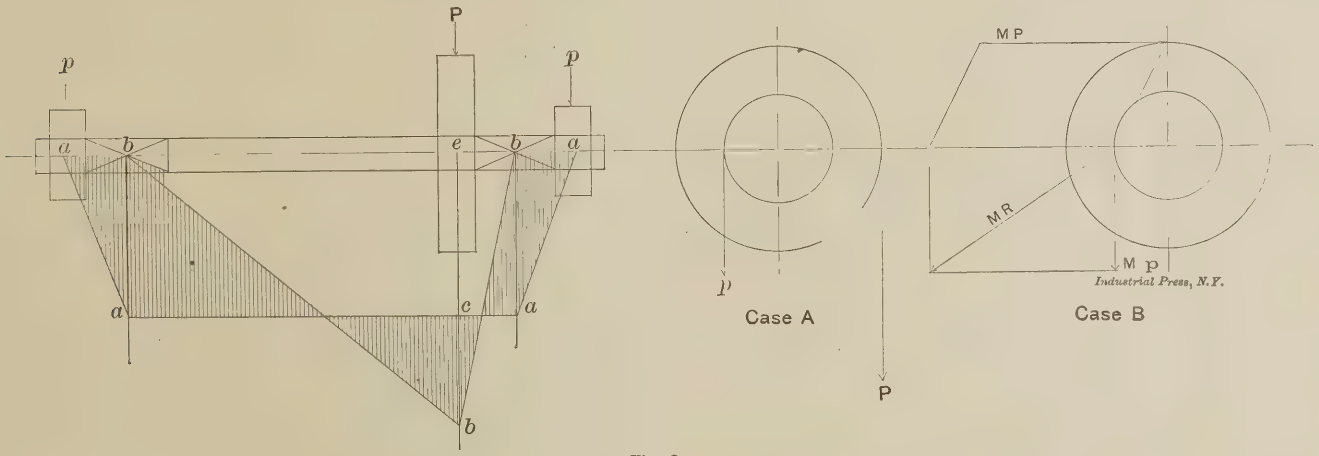


Fig. 2.

Gears, drums and other detail parts are so distributed upon shafting as to cause combined strains, and the maximum fiber stress resulting therefrom must be determined. A simple case is that of two gears between bearings, Fig. 1, the large and small gear respectively carrying loads P and p, the loads acting in the same direction. Connect P and p by a line cutting the axis at b.

Since the shaft must be in equilibrium, we have

$$p \times da = P \times ec,$$

$$\frac{p}{P} = \frac{ec}{da}$$

By the law of similar triangles,

$$\frac{ec}{da} = \frac{eb}{bd}$$

and substituting we have,

$$\frac{p}{P} = \frac{eb}{bd}$$

$$p \times bd = P \times eb.$$

The reaction at b is then $p + P = W$, and the bending moment is

$$M = \frac{WAB}{L}$$

The torsional moment is,

$$T = p \times da,$$

$$k = \frac{M}{T} = \frac{WAB}{L \times p \times ab} = \frac{(p+P)AB}{L \times p \times ab}$$

$$k = \frac{MR}{T} = \frac{11,248}{6,930} = 1.6, \text{ the corresponding value of } n$$

being 1.51.

$$\frac{T}{f} = \frac{6,930}{9,000} = 0.77$$

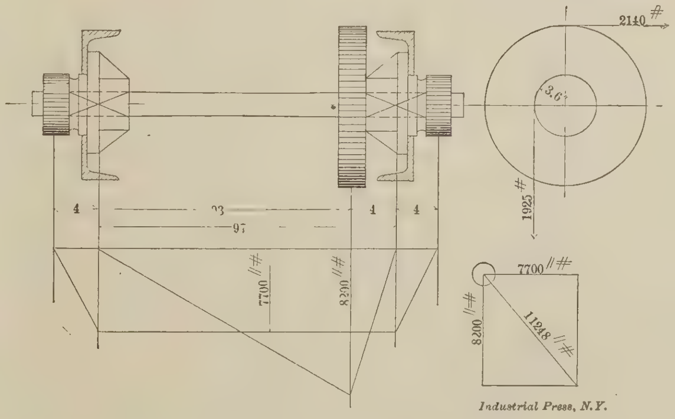


Fig. 3

From the table of values for twisting moments we find the nearest constant above 0.77 is 0.842 for a 1⅝-inch shaft. Then 1.625 × 1.51 = 2.45 inches for the required diameter of the shaft.

In all such cases as the above example, in which a shaft is supported upon channels or other unsymmetrical supports, the

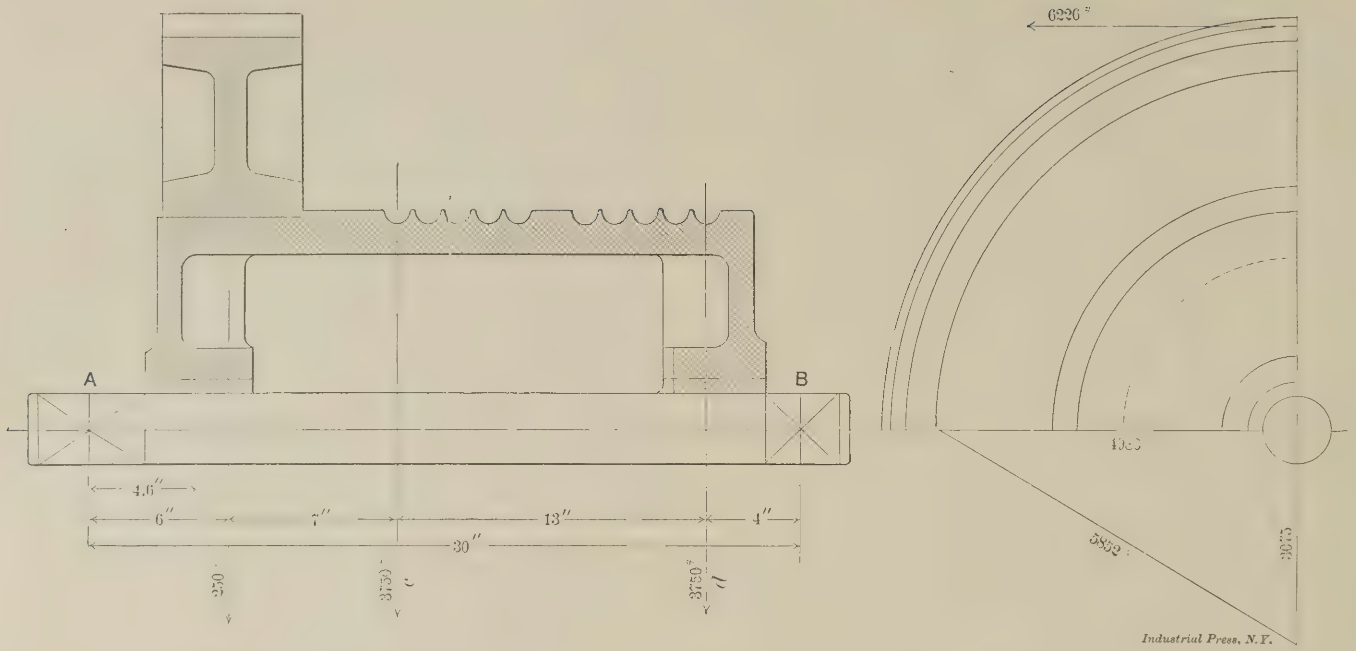


Fig. 4.

bending moment must be calculated to the center of gravity of the supporting member.

Example: In Fig. 4 we have a drum shaft of given dimensions and following conditions: Drum loose on shaft and bushed; weight of drum 500 pounds; two ropes leading from drum each under 3,750 pounds load; tooth load on drum gear horizontal; rope loads vertical; fiber stress to be 10,000 pounds per square inch. Resolving all loads to the heavier loaded journal we have,

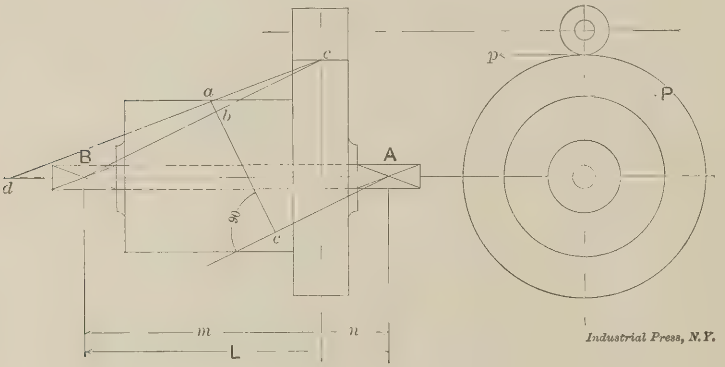


Fig. 5.

$$\frac{6{,}226 \times 24}{30} = 4{,}980 \text{ pounds horizontal load.}$$

$$\frac{3{,}750 \times 17}{30} = 2{,}125 \text{ pounds, rope } c.$$

$$\frac{3{,}750 \times 4}{30} = 500 \text{ pounds, rope } d.$$

$$\frac{250 \times 24}{30} = 200 \text{ pounds, weight of gear.}$$

$$\frac{500}{2} = 250 \text{ pounds, weight of drum.}$$

$$\text{total} = 3{,}075 \text{ pounds vertical load.}$$

The resultant of the horizontal and vertical loads on A is 5,852 pounds.

Then $M = 5{,}852 \times 4.6 = 26{,}919$ inch-pounds.

$$\frac{M}{f} = \frac{26{,}919}{10{,}000} = 2.69$$

In the table of values for simple bending moments, the nearest constant is 2.7 for a 3-inch shaft.

Fig. 5 shows a common arrangement of drum and gear, in which *a* is the center of gravity of the rope loads *P*. Where there are two ropes on the drum, the position of *a* is constant, while for one rope the position of *a* varies along the drum, and for the latter case several solutions should be made with varying positions of *a*. The load is supported upon three points, the journals *A* and *B* and the gear teeth at *C*. The load *P* puts a downward load upon each journal *A* and *B*, and is divided proportionally between them. In the figure *a* is central, so the loads upon *A* and *B* are equal, and are $\frac{P}{2}$; the upward load *p* at *C* is divided proportionally between *A* and *B*; thus we have

$$\left.\begin{array}{l}\text{Load at } A = \dfrac{C\,m}{L} \\[2ex] \text{Load at } B = \dfrac{C\,n}{L}\end{array}\right\}\text{upward loads.}$$

$$\text{loads at } A \text{ and } B = \frac{P}{2}, \text{ downward loads.}$$

The algebraic sum of the two loads upon either journal gives the amount and direction of the resultant load on the journal. Draw *B C* and *Ca* produced to cut *A B* at *d*. We thus represent the load *P* as eccentrically supported upon a beam *B C*, at an arm *ab*, and prevented from rotating about *B C* as an axis by the reaction of journal *A* acting at an arm *bc*.

We thus have

$$\text{Load at } A = \frac{P \times a\,b}{b\,c} = W, \text{ upward load.}$$

$$\left.\begin{array}{l}\text{Load at } C = \dfrac{(P + W)\,B\,b}{B\,C} \\[2ex] \text{Load at } B = \dfrac{(P + W)\,C\,b}{B\,C}\end{array}\right\}\text{downward loads.}$$

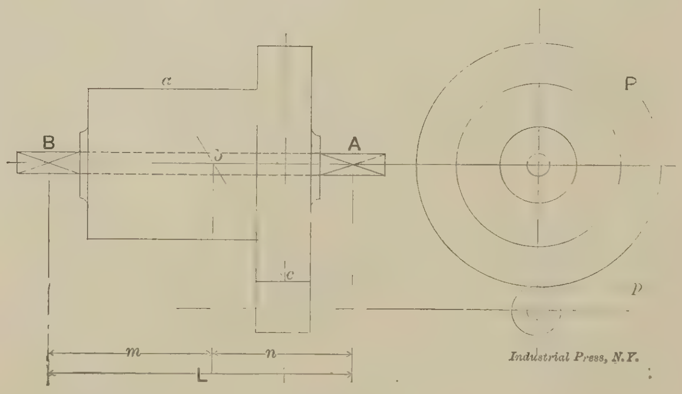


Fig. 6.

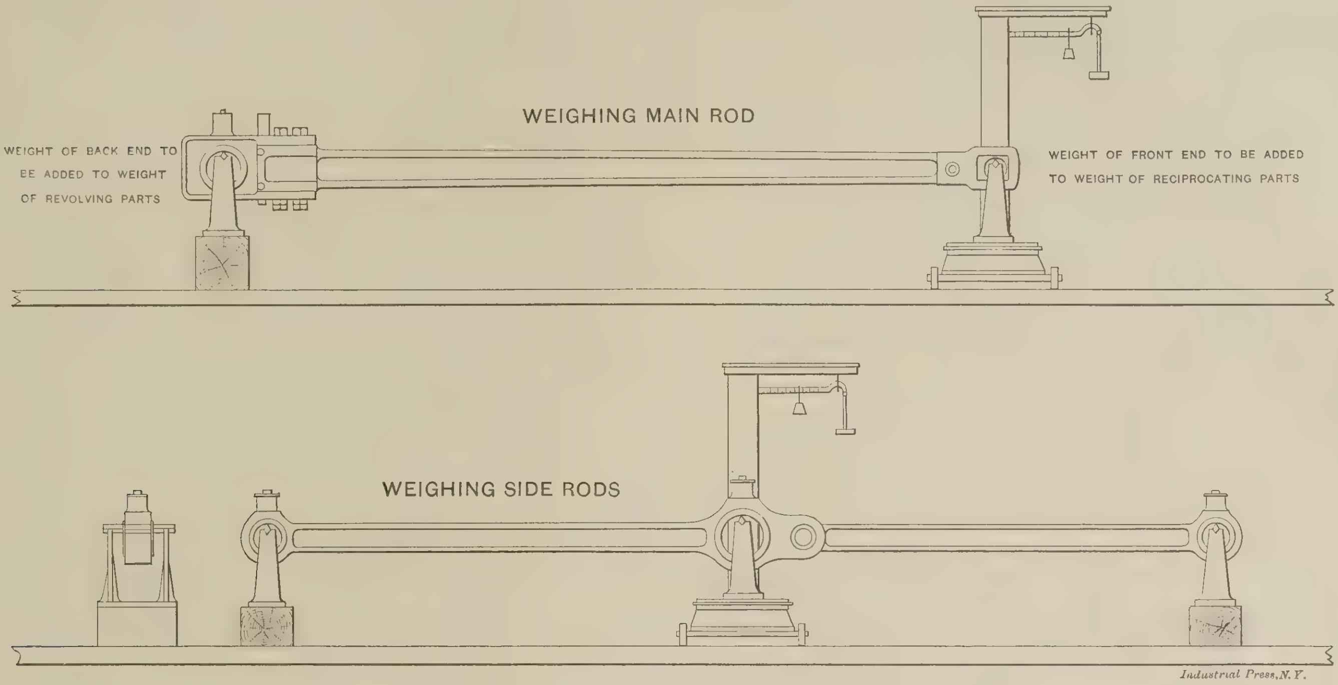
The condition of loading at journal *A* is seen from the position of point *d*, which lying beyond *B* as in the figure, indicates an upward load at *A*, lying on *B* indicates no load at *A*, and lying between *A* and *B* indicates a downward load at *A*, the weight of the drum and gear being neglected.

Fig. 6 shows the same arrangement with the pinion on the opposite side from *a*, and this case is analagous to that shown in Fig. 1.

COUNTERBALANCING LOCOMOTIVES.

G. E. LEE.

Every locomotive and railroad shop presumably has its own method of counterbalancing locomotive drivers and no doubt they prove generally satisfactory. The writer has used the following method with good results, and to make it is clear as possible an example has been taken which was used in actual experience.


WEIGHING MAIN ROD
WEIGHT OF BACK END TO BE ADDED TO WEIGHT OF REVOLVING PARTS
WEIGHT OF FRONT END TO BE ADDED TO WEIGHT OF RECIPROCATING PARTS
WEIGHING SIDE RODS

Industrial Press, N. Y.

Fig. 1. Method of Weighing Main and Side Rods.

The accuracy of the method was tested by the wheels being pressed in place on the axles, crank-pins fitted and the whole mounted and leveled on horses where weights hung on the crank-pins until they balanced the weight of the counterbalance. These weights were found to be within a few pounds of the required weight; also when the engines were in service and running at a high rate of speed there was no indication that the wheels were out of balance. The accompanying forms and tables, Figs. 2 and 3, were used for keeping records. They are made on tracing cloth and printed on Vandyke solar paper, which is used as a negative for producing prints on ordinary blueprint paper, making blue lines on white ground. By filling in the weights a record can be kept and filed away.

Taking for our example a ten-wheel engine, weighing, in working order, 134,000 pounds, cylinders 19 x 24 inches, and using the form, all the figures are estimated from the drawing. But if the parts have previously been made, which, in this case, were all finished, the actual weights are taken. The side rods are coupled together and the weights for each pin taken as shown in Fig. 1. The rods are then uncoupled and weighed separately or all together. This serves as a check, as both totals should be equal. One-third of the main rod weight is considered in the reciprocating weights when the weight of the rod is estimated and the other two-thirds in the revolving weight. The crank-pins are estimated or weighed before being pressed into the wheels, and the weights of the crank-pin hubs and that portion of the counterbalance between the spokes are found in the following manner:

The driving wheel pattern is first made with the axle hub, rim and spokes finished to size and is then weighed. The crank-pin hub is then made and fitted into place and the wheel again weighed, the difference being the weight of the crank-pin hub, but from this weight must be taken the weight of that portion representing the crank-pin fit in the wheel. This is found by taking a block of the same material and turning it to the diameter of the crank-pin fit, and cutting it off to the length of the hub. The weight of this block taken from the above weight gives the required weight of the crank-pin hub in wood. Next take a block of wood, say, 3 x 5 x 8 inches (be sure this also is of the same material), which equals 120 cubic inches and weighs 1 pound 11 ounces, equal to 27 ounces, and find the actual weight in metal by using the factor for the material of the wheel which is .26 pound per cubic inch for cast iron. (See example in the column of notes on the form, Fig. 3.) The weight of the counterbalance between the spokes is found in the same way, the balance being made the thickness of the spokes, as shown by the sketch on the form, Fig. 3. Having found these weights we next find the total weight to be balanced.

We adopt the recommendation of the Master Mechanics' Association contained in their report of 1896 for the amount of the total weight of engine to be added to the revolving weights. We have, total weight of engine, 134,000 pounds, divided by 400 equals 335. This subtracted from the total

COUNTERBALANCE

REPORT FROM SHOP

WHEEL CARD NO.________ENGINE NO.____________CLASS____________

NOTE:-
COLUMNS A & B FILLED IN BY DRAWING ROOM

RECIPROCATING WEIGHTS	A ACTUAL WEIGHT	B ESTIMATED WEIGHT	DIFFERENCE	REMARKS
PISTON & ROD COMPLETE	311			
CROSSHEAD & PIN "	226			
FRONT PART OF MAIN ROD	167			
TOTAL	704			

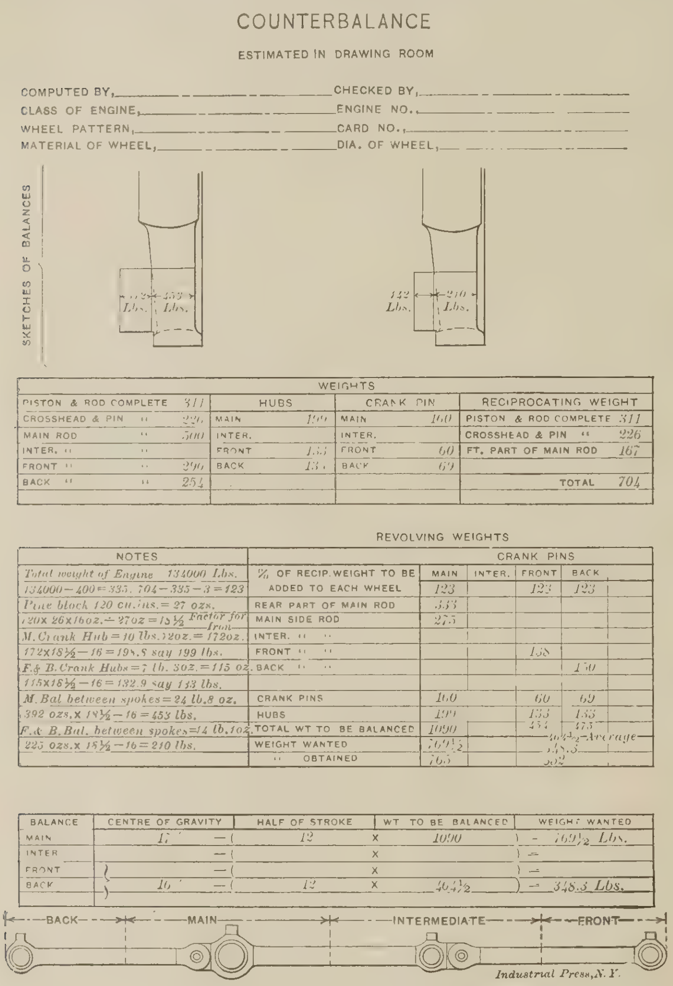
REVOLVING WEIGHTS	A ACTUAL WEIGHT	B ESTIMATED WEIGHT	DIFFERENCE	REMARKS
REAR PART OF MAIN ROD	333			
COUP. ROD ON MAIN PIN	275			
" " " INTER. "				
" " " FRONT "	126			
" " " BACK "	138			
CRANK PINS				
MAIN	160			
INTERMEDIATE				
FRONT	60			
BACK	69			

WEIGHTS TO BE HUNG ON CRANK PINS	MAIN 731		INTERMEDIATE		FRONT 267		BACK 267			
ACTUAL WEIGHT HUNG ON CRANK PIN	R 700	L 740	R	L	R 273	L 277	R 280	L 270	R	L
AVERAGE	720				Average		275			
DIFFERENCE	Light 11 Lbs.				Heavy		8 Lbs.			

Industrial Press, N. Y.

Fig. 2. Record of Shop Report

reciprocating weight and the difference divided by 3 (the number of wheels on one side), or 704 — 335 ÷ 3 = 123 pounds. The amount is the weight to be added to each pin. Now take the total weight to be balanced on the main pin, 1,090 pounds, multiply it by one-half of the stroke of the piston and divide the result by 17 (the distance in inches of the counterbalance center of gravity from the axle center). We find this to be 769½ pounds, which equals the weight wanted in the balance. Now referring to the form, Fig. 3, and in the column of notes we find the weight of the balance in iron between the spokes to be 453 pounds and the weight of the balance outside of the spokes is 312 pounds, giving a total of 453 + 312 = 765 pounds for the balance. This is 4½ pounds lighter than the estimated weight required.


SKETCHES OF BALANCES
312 Lbs.
453 Lbs.
142 Lbs.
210 Lbs.
BACK
MAIN
INTERMEDIATE
FRONT

COUNTERBALANCE

ESTIMATED IN DRAWING ROOM

COMPUTED BY, ____________ CHECKED BY, ____________
CLASS OF ENGINE, ____________ ENGINE NO., ____________
WHEEL PATTERN, ____________ CARD NO., ____________
MATERIAL OF WHEEL, ____________ DIA. OF WHEEL, ____________

WEIGHTS							
PISTON & ROD COMPLETE	*311*	HUBS		CRANK PIN		RECIPROCATING WEIGHT	
CROSSHEAD & PIN "	*226*	MAIN	*199*	MAIN	*160*	PISTON & ROD COMPLETE	*311*
MAIN ROD "	*500*	INTER.		INTER.		CROSSHEAD & PIN "	*226*
INTER. " "		FRONT	*133*	FRONT	*60*	FT. PART OF MAIN ROD	*167*
FRONT " "	*290*	BACK	*133*	BACK	*69*		
BACK " "	*254*					TOTAL	*704*

REVOLVING WEIGHTS

NOTES	CRANK PINS				
Total weight of Engine 134000 Lbs.	% OF RECIP. WEIGHT TO BE ADDED TO EACH WHEEL	MAIN	INTER.	FRONT	BACK
134000 − 400 = 335. 704 − 335 − 3 = 123		*123*		*123*	*123*
Pine block 120 cu. ins. = 27 ozs.	REAR PART OF MAIN ROD	*333*			
120 x 26 x 16 oz. ÷ 27 oz = 18½ Factor for Iron	MAIN SIDE ROD	*275*			
M. Crank Hub = 10 lbs. 12 oz. = 172 oz.	INTER. " "				
172 x 18½ − 16 = 198.9 say 199 lbs.	FRONT " "			*158*	
F. & B. Crank Hubs = 7 lb. 3 oz. = 115 oz.	BACK " "				*150*
115 x 18½ − 16 = 132.9 say 133 lbs.					
M. Bal between spokes = 24 lb. 8 oz.	CRANK PINS	*160*		*60*	*69*
392 ozs. x 18½ − 16 = 453 lbs.	HUBS	*199*		*133*	*133*
F. & B. Bal. between spokes = 14 lb. 1 oz.	TOTAL WT TO BE BALANCED	*1090*		*474*	*475*
				464½ Average	
225 ozs. x 18½ − 16 = 210 lbs.	WEIGHT WANTED	*769½*		*348.3*	
	" OBTAINED	*765*		*352*	

BALANCE	CENTRE OF GRAVITY		HALF OF STROKE		WT TO BE BALANCED		WEIGHT WANTED
MAIN	*17*	— (	*12*	x	*1090*	) =	*769½ Lbs.*
INTER		— (		x		) =	
FRONT		— (		x		) =	
BACK	*16*	— (	*12*	x	*464½*	) =	*348.3 Lbs.*

Industrial Press, N. Y.

Fig. 3. Record of Drawing Room Estimate.

Now referring to the weights returned from the shops, we find the average weight hung on each of the wheels as follows: On the main crank-pin it was 720 pounds, which, when compared with the revolving weights, *i. e.*, the sum of 123, 333 and 275 pounds = 731 pounds shows the balance to be 11 pounds light, but it is near enough for all practical purposes. The weights for the front and back wheels, being so nearly the same, their average was taken and the one pattern used for both. In the front and back wheels the balance is 8 pounds heavy, which makes a total of 16 pounds, and taking from that the amount the main balance is light, it leaves the combined balances 5 pounds heavy on one side.

If it is found that the balance cannot be made large enough to obtain the required weight, pockets must be cored in the balance and filled with lead. This will require a separate calculation, taking into account the difference between the weight of lead and iron, also the center of gravity of the pockets and balance.

* * *

The basis of estimating the size of hoist needed at a large mine is not, as might be thought, the amount of ore to be raised, but rather the hoisting and lowering of the men. In a large mine, where at the changing of shifts 100 men must be lowered and 100 men raised, it is important to effect the change as quickly as possible, otherwise in the aggregate a great deal of time will be lost.—*Mining Reporter.*

A WALKING LOCOMOTIVE.

In the April, 1903, issue an illustrated description was given of a novel traction engine called the "pedrail," which is the invention of Mr. B. J. Diplock. The pedrail is a "walking locomotive," being, as a recent consular report puts it, "a half traction engine and half walking machine." The machine is of grotesque appearance, but it seems capable of performing wonderful feats in negotiating bad and difficult roads—roads that, for any other traction vehicle, would be quite impossible and scarcely possible for those drawn by horses. It has been described as a traction engine which actually and literally walks upstairs with the stride and sure-footedness of an elephant and hauls loads behind it under circumstances that would bring an ordinary traction engine to a standstill. Ruts, curbstones and boulders it makes nothing of, and even 9-inch sticks of timber are as stubble before it.

"The pedrail indicates by its name that it is a rail carried upon feet. Instead of having a permanent rail carried for the whole of its length on permanent feet, viz., sleepers, and wheels running upon this rail, the process is inverted. The feet are (as in the case of the railway) placed upon the ground, but instead of the rails being carried upon the feet, these feet support wheels, and the wheels thus supported act as bearers for a short length of rail attached to the moving carriage. Briefly, the invention might be described as replacing the wheels of an ordinary traction engine by revolving frames carrying sliding spokes, each spoke having at its end a circular foot, and on the spoke itself, at a little distance above the foot, a small wheel or roller. In connection with each series of revolving spokes a fixed frame is attached to the side of the traction engine. This fixed frame somewhat resembles in form an inverted heart. When the axles revolve the spokes are carried round and in turn place the feet upon the ground. At the same time the wheels, which run round in contact with the heart-shaped frame, when brought underneath it—that is, under what may be described as the broader portion of the heart—act in turn as supports for the heart-shaped frame to glide over. Hence the engine is itself supported in turn through the wheels by the spokes which happen at the time to be resting with their feet upon the ground.

"The action of the pedrail on the road is very remarkable. Whereas the ordinary traction engines destroy roads to such an extent that they have been forbidden in many parts of this country and also in various parts of the world, and heavy motor wagons and traction engines have been severely taxed by local authorities and made to contribute to the repair of the roads, the pedrail positively improves the road over which it walks. This has been proved by actual experiment, and it is more than probable, from the remarks of an eminent municipal engineer, that the pedrail is destined to entirely replace the road roller for repairing roads, as the action of stamping or ramming is much better than rolling for this purpose."

* * *

One of the oldest weighing machine building concerns in the world, if not the oldest, is that of W. & T. Avery, Ltd., of Birmingham, England. Readers of MACHINERY will remember that in the November, 1902, issue a short history of this concern was given, in which the date of its founding is stated to be 1730. This old firm have a world-wide reputation and have always, it is said, been leaders in their specialty, which is weighing machines of all kinds from the heaviest track scales to the most delicate chemical balance. A recent interesting development in weighbridges made by the firm is one on which each car of a moving railway train can be weighed while traveling over it at the rate of about three miles per hour. As each car passes, its weight is indicated accurately on a dial without wavering or fluctuations, as would be expected from the nature of the conditions. This result is effected in part by the use of "lead-on" rails, which are short lengths of rails in the track having one end resting on a solid foundation and the other end upon the girders of the weighbridge. In this manner the weight comes upon the weighing levers gradually instead of being instantly transferred to same. The dial indicating mechanism is of a new type, in which the use of springs is done away with.

HIGH PRESSURE GAS DISTRIBUTION BY GAS POWER.

A gas power installation of exceptional interest is now under construction by the Laclede Gas Light Company, of St. Louis, Mo. The system has for its object more efficient distribution of gas over larger areas than may be economically covered by the simple method of running large low pressure mains from a centrally located gas generating plant to supply all parts of the city. The system under construction is intended to supply the entire city of St. Louis, embracing an area of approximately 65 square miles.

It is evident that in order to serve the outlying districts of such an area, one of three methods must be employed: 1st, large low pressure feeder from central holder to center of district to be covered; 2nd, medium sized feeders from main holder to auxiliary holder in center of district; and 3rd, high pressure feeder to distributing center, using pressure reducing valves at this point for obtaining proper pressure upon the service lines. The enormous expense for construction entailed by the first two methods has practically prohibited their use in St. Louis, and the high pressure system is being installed. With this system the size of feeder pipes is greatly reduced and the necessity of auxiliary district holders is entirely done away with.

For serving suburban communities, lying far beyond the city limits, this method may be extended and the pressure of the gas raised to any desirable extent for transmission through small pipes, this pressure being reduced at the suburban distributing center by pressure regulators, as in the medium pressure system above mentioned.

This gas distribution system as a whole presents a striking similarity to the ordinary alternating current distribution system with primary high pressure feeders, reducing transformers and secondary low pressure distributing lines, the theory of high pressure transmission being in both cases identical.

The pressures to be employed in the system under construction at St. Louis are approximately 5 pounds per square inch for the medium pressure feeders and from 20 to 80 pounds per square inch for the high pressure suburban feeders. On account of the use of cast iron mains, the 5-pound limit was chosen for the medium pressure system, but for the high pressure system iron pipe with screwed fittings will be used. With this construction any desirable pressure may be carried with entire safety and the radius of distribution extended to 100 miles if necessary.

In the medium pressure system, the gas pressure will be supplied by a blowing unit, consisting of a standard Connersville blower direct driven by a 300-horsepower Westinghouse, horizontal gas engine. The engine is of the type recently brought out for high power work and embodies a number of newly developed features which distinguish the construction of the horizontal type. The engine has two double acting cylinders, 16½ inches in diameter and 24 inches stroke, arranged in tandem with a single crank. The engine uses for fuel the ordinary illuminating gas such as is distributed to customers and draws its supply directly from the gas main. The engine operates upon the four-stroke cycle and the method of governing secures a constant quality of explosive mixture at all loads, the quantity of the mixture being proportioned by the governor to the load on the engine. Electric ignition is employed.

In this particular installation the engine is controlled by an automatic pressure governor which adjusts the speed of the unit in direct proportion to the demand for gas, the speed thus being in inverse proportion to the pressure in the distribution main. So sensitive is this control that the variation in pressure will not exceed eight ounces for a 50 per cent. range in gas output. The regular centrifugal speed governor is, however, also used in order to prevent, under any conditions, the engine running at excessive speed.

The St. Louis installation is one of the first of its kind in the illuminating gas field and presents many interesting features. The system has, however, long been in successful use in the distribution of natural gas over large districts adjacent to natural gas fields.

FRENCH TRACTION TRAIN FOR HIGHWAYS.

In Consular Report No. 1866 there appears a translation from a French journal briefly describing an "automobile railroad," which term, however, seems quite erroneous since the plan is one for coupling together road vehicles, each acting as its own tractor and traveling on ordinary roads having no rails at all. The description, nevertheless, is of considerable interest and relates to the road train designed by Col. Renard.

"This train is designed to transport passengers and merchandise at a moderate speed. Up to the present, automobilism has been, above all, synonymous of speed. Each manufacturer has bent his every effort to construct a type more rapid than his competitors. As to vehicles destined to carry heavy loads at slow speed, these have disappeared from the eyes of the public before the greater number of rapid carriages. If this means of transportation which responds to real needs has not been more fully developed, it is largely due to difficulties of a technical order. There are two ways of solving the problem—either to use isolated vehicles, or to hitch a locomotive tractor to a train of coaches or wagons. The first solution is evidently the more expensive, since it requires a motor for each vehicle and a motorman to conduct it, besides it only permits of transporting a relatively light load, unless the vehicles are made of weight and dimensions too great to be practical. As to road trains, they have encountered grave difficulties.

"In this train there is, so to speak, no hauling tractor. One of the carriages, the head one, is furnished with a motor —steam, gasoline or spirits—sufficiently powerful to draw the entire train at the desired speed. The power engendered by the motor is distributed to all of the vehicles of the train, and each one of them is provided with an arrangement by the aid of which the energy that is due to it is employed to work a pair of wheels, so that each carriage is a tractor to the same degree as the first, with the difference that the first is at the same time a "factor of energy."

"Each carriage works itself with the same facility as an isolated automobile. The adherence is therefore no longer due to the weight of the tractor, but to the weight of the entire train. One can thus make the tractor as light as an ordinary carriage and hitch it to as many carriages as desired without fearing the least sliding. The automobile at the head of the train, provided with a motor of 50 horse power, weighs only 1½ tons, and it suffices to furnish the necessary energy to draw a mixed train—passenger and merchandise—formed of seven or eight light vehicles, carrying a load of 10 tons, at the rate of about 12 miles an hour. The method of transmission of the energy from the motors to the diverse carriages is purely mechanical. It consists of a longitudinal shaft running from one end of the train to the other. The shaft is articulated in a manner to permit the train to negotiate curves.

"The parts uniting the different carriages are easily uncoupled to permit the separation or reunion of the carriages at will. Under each carriage there are gears which transmit the rotary movement of the shaft to an arrangement similar to that used in automobiles and working one pair of wheels. All of this obeys the manipulation of one motorman on the locomotive carriage at the head of the train. To conduct such a train involves no more difficulty than that of running an ordinary automobile.

* * *

Lead pipe, lead wire and similar lead productions are made by forcing the lead under heavy hydraulic pressure through perforated plates or dies. The containing vessel is first filled with melted lead, which is allowed to cool and solidify. In the manufacture of lead wire a pressure of about 40 tons per square inch is required to force the lead through the die. In the manufacture of lead pipe a mandrel is suspended in the chamber so as to project into the hole and stand concentrically within it. Electric cables are covered with a lead sheath in the same manner, the cable itself acting as the mandrel and being traversed through the container at the same rate as the formation of the sheath.

* * *

The National Machine Tool Builders' Association will hold their next convention in Cincinnati on Tuesday, April 26, 1904.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

It is reported that the United States Steel Corporation are installing the continuous rolling process in one of their Pittsburg plants. Although the process is not entirely automatic it requires fewer rollers, heaters and finishers so that the tonnage product per man will be practically more than doubled with no more exertion on their part than now. The question is how long will it be before the production of steel shapes from the ore will be almost entirely done by automatic machinery; it is rapidly approaching that condition already. One of the greatest changes in the industry has been the substitution of machinery for doing work that a few years ago required scores of toiling, sweating men, working under conditions often unbearable in the summer months.

In a paper read by Mr. N. Lilienberg before the Philadelphia Foundrymen's Association, on the history of steel plant construction, reference is made to the well-known fact that in 1856 Sir Henry Bessemer made the first steel produced by blowing air through pig iron. The priority was disputed some years ago by an American, but the claim does not seem to have been sustained. It has also been asserted that the process was in secret operation at Essen in Germany for some years before 1856, which, if true, shows the danger of conducting a manufacturing business on the trade-secret plan. The first steel converter was stationary, cylindrical, with radial side tuyeres near and parallel to the bottom. The pig metal was poured in through a hopper on the side. The flame escaped through a central hole in the top. Sir Henry Bessemer anticipated by patents many ideas which were afterward taken up by the others as original.

The B. F. Sturtevant Co., Boston, Mass., report that in the case of the Baltimore conflagration the old adage, "There is no great loss without some small gain," holds true; at least, to a limited extent. The salvage companies, who salvage goods damaged by fire and sell them for the benefit of the fire insurance companies, will profit by this loss. The goods damaged must be carefully dried before they become salable, and the Underwriters Salvage Co., of New York City, have placed an order with the Sturtevant Co. for the equipment of a kiln for drying such goods. The kiln is divided into small rooms of various widths served by overhead tracks from which are suspended frames for supporting two tiers of baskets for the reception of the water-soaked material. These rooms are of fireproof construction and the size is governed by the material to be dried. Hot air is diffused through the rooms while the amount of air and its temperature are easily controlled.

A suspended car ferry having a span of 393 feet is to be erected at Duluth, Minn. It is in effect a highly elevated bridge, the towers being 136 feet high, under which vessels freely pass, but the floor of the suspended car is only slightly elevated above the general street level. The motive power will be electricity, the motor operating wire cables attached to the trolley from which the framework and car are suspended. The car will carry a load of about 60 tons, which means that it can carry one street car, two or three teams, and altogether about 200 passengers. Its length will be 50 feet and the width 40 feet. It is pointed out that the suspended car ferry is superior to a drawbridge, as it practically does not interfere with navigation at all beyond that the vessels must avoid collision with the car, which, of course, is a duty devolving on both. The cost of the structure will be about $100,000. This is to be the first suspended car ferry built in this country.

A destructive explosion of two water-tube boilers in the power plant of the St. Louis Transit Company occurred December 21, 1903, in which seven men were killed and property damaged to the amount of $50,000. In view of the repeated assertions that a disastrous explosion of standard representative types of water-tube boilers is practically impossible, this disaster is interesting, inasmuch as the findings of the coroner's jury and the testimony taken indicate that it was caused by inadequate inspection and gross neglect, the immediate cause being thought to be over-pressure due to a stuck safety-valve. It was discovered after the explosion that some of the safety valves were so badly stuck that it is probable they would not have lifted with three or four times the rated pressure. The fact of the matter in regard to the operation of steam boilers is that no boiler is "safe" even with the most vigilant and unceasing care, but almost any type of well-built boiler is reasonably secure under competent supervision. That "eternal vigilance is the price of safety" in the boiler room there is no doubt.

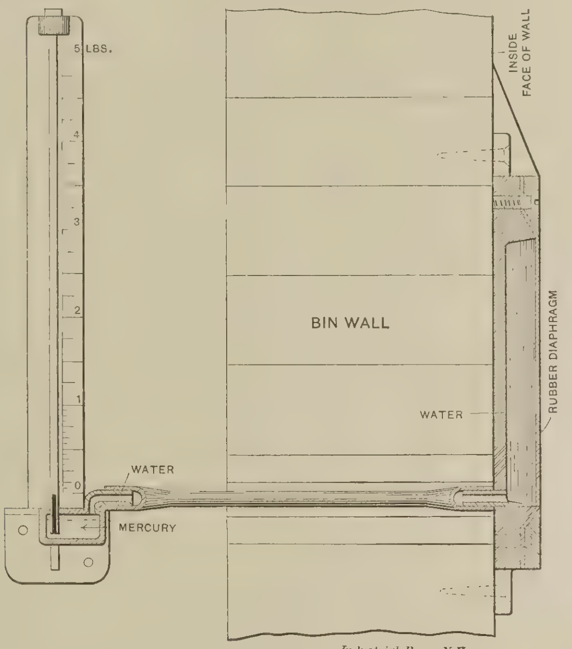
From the as yet incomplete reports of the Baltimore fire, February 7, it would appear that the best types of the so-called fireproof buildings suffered comparatively small damage structurally, although their combustible portions and contents were destroyed. This is notably the condition in the Continental Trust Company building, where a superficial examination has shown the building to stand plumb and the frame to be uninjured save in some minor instances where exposed to the flames. The fire has unquestionably demonstrated the superiority of brick, terra-cotta and other "fired" constructive materials over marble, granite and other natural stones that chip and crack when exposed to comparatively low temperatures. The fire has also demonstrated the weakness of fire-fighting apparatus of the old type depends for its efficiency upon the mere squirting of small streams of water from hose. All high structures must be equipped with standpipes with hose connections on each floor or sprinkler systems in the case of warehouses stored with combustible materials.

One of the serious problems of business in large commercial centers is the transportation of merchandise within the city limits. Horse-drawn trucks are slow and expensive under ordinary weather conditions, and often hopelessly impeded in progress by winter storms. Moreover, from a humanitarian point of view the use of the horse in city streets is to be deplored. But the automobile truck has not yet reached the degree of development that warrants its use for general purposes to the exclusion of the horse. It is peculiarly susceptible to delay by snow in winter and it requires a driver more capable and experienced than many firms can afford to employ. The logical method of handling the freight of a great city seems to have been quite unexpectedly developed in Chicago, and in a peculiar way. Chicago now has a system of tunnels, built originally for telephone and telegraph wires, which is also to be used for narrow-gage railway tracks for freight purposes. The gage of the tracks is to be 24 inches and the motive power will, of course, be electricity supplied by a third rail. The cars will be about 12 feet long over all, made of steel and iron, and will be of the double-truck, eight-wheel type. Since the network of tunnels burrows under most of the principal business streets it follows that all concerns on these streets may discharge and receive freight through their basements without exposure to the weather and without hindrance to public traffic. The Illinois Tunnel Company, controlling the project, expect to be able to handle not less than 50,000 tons of freight a day by the beginning of 1905. The system connects with six large railway freight depots, so that team work is entirely unnecessary. The advantages of the subway system will undoubtedly overbalance the great cost of such undertakings, and we may look forward to the time with confidence when such systems will be the rule rather than the exception in large cities.

THE PRESSURE OF GRANULAR SUBSTANCES ON THE WALLS OF DEEP BINS.

An interesting and valuable contribution to the meager data on the side and vertical pressures of granular substances stored in deep bins, with special reference to grain bins, was made in a paper read by Mr. J. A. Jamieson before the Canadian Society of Civil Engineers. The subject as it affects grain bins, has acquired an added significance since the construction of wooden grain elevators with rectangular bins is being abandoned in favor of fireproof elevators with circular steel bins. The sides of a wooden bin, if made strong enough to resist the lateral pressure, are amply strong to support the vertical pressure due to friction of the stored material. But a steel bin made on the water stand-pipe plan, might have a great excess of lateral or bursting strength and still fail by collapsing vertically.

It is pretty well understood by experienced grain elevator engineers that grain stored in bins of standard dimensions (12 to 14 feet square and 60 to 70 feet deep) produces comparatively small vertical loads on the bottom and lateral pressures on the sides, the greater part of the load being carried vertically by the side walls. It is also pretty well understood that the fluid pressure theory does not apply to stored grain and other granular substances, but very few understand how these effects are governed by the ratio of breadth to the depth of the bin, etc. The paper gives in detail the experiments made on standard size grain bins; also on model bins to determine the pressures, friction co-efficient, etc.



Industrial Press, N.Y.

The matter of weighing the pressures developed on the sides of a full-sized grain bin was a problem of considerable difficulty. Several styles of weight scale-levers and beams were designed and rejected in favor of a hydraulic diaphragm and a mercury or water column gage of the form shown in the cut. A gage of this form was placed on the side a short distance above the bottom and one was placed in the bottom of a Canadian Pacific Railway elevator bin 12 feet by 13 feet 6 inches by 67 feet 6 inches which was filled with Manitoba wheat weighing 49.4 pounds per cubic foot. The grain was run into the bin in drafts of 30,000 pounds and the first draft had a clear drop of 70 feet. Each draft filled a section 3 feet 9 inches high and readings were taken after each draft. After standing 18 hours there was practically no change in the final reading of the gage, and when the grain was drawn off at the rate of 9,000 bushels per hour, the readings fluctuated considerably with a maximum increase of 4 per cent. over that obtained when filling the bin. When the valve was suddenly closed there was a slight increase of pressure and a corresponding decrease when the valve was opened.

The reading of the gage when the first draft was leveled off showed that the bottom of the bin carried 86.9 per cent. of the total weight of the grain, the remaining 13.1 per cent. being carried by the sides. The proportion of weight carried on the bottom steadily decreased as the bin was filled until when filled only 17.8 per cent. of the weight was carried on the bottom and 82.2 per cent. was supported by the friction of the grain on the sides. The side pressure tests were tabulated and give equally as striking results. With the first draft the equivalent fluid pressure would be 1.29 pounds per square inch; actually it was 0.34 pounds. When the bin was filled with grain, the total weight of which was 540,000 pounds, the side pressure was 2.46 pounds per square inch while the equivalent fluid pressure would have been 23.15 pounds.

A PARALLEL BETWEEN AMERICAN AND EUROPEAN INDUSTRIES.

Le Mois scientifique et industriel, October, 1903.

As a result of the importation into Europe of the first American machine tools, steam and gas engines and locomotives, and more particularly as a result of the exaggerating newspaper articles, which tend to give an inflated importance to the New World industries, the public as well as the manufacturers of the Old World are too easily led into an unwarranted admiration of American industrial methods. Certainly we have no wish to dispute the fact that American manufacturers are possessed of great initiative and a remarkable activity; a capability of making a quick decision and one that is almost always intelligently directed, a great capacity for work and a strong tenacity of purpose in attaining a desired end. What we wish to set forth is how American industrial practice differs from the European and from our own in particular.

The Americans are intolerant of that which is "good enough," and especially of mediocrity. If a plant is behind the times or the efficiency of a machine is not up to that of the most modern construction, the plant is remodeled and the machine overhauled and improved. Everything that can contribute toward the attainment of better results is considered necessary and indispensable.

In Europe, and especially in France, we have remained content up to the present with fairly good results; we fear changes that may modify the economic results, even though they are more satisfactory and certain, and we too frequently hesitate to take advantage of the benefits that may accrue from an improvement of the plant. Although the genius of our inventors and the scientific attainments of our engineers are fully equal to the Americans, yet it must be frankly avowed that what we do lack is that spirit of practical progress that characterizes all in America from the ordinary workman to the manager of a great industry. The old methods of doing business in Europe have not been changed for a long time, and in order to successfully compete in the markets of the world it is essential that we should work more in accordance with modern methods and with tools of the latest construction that will operate more rapidly and diminish hand work to the lowest notch.

The Americans have, furthermore, a special insight into manufacturing methods. They believe in constant progress. Hence, they build their machines and design their plants so that either can be readily renewed when it becomes necessary; and they always calculate upon a rather rapid depreciation. When this depreciation equals the original value of the machine they do not hesitate to throw the latter into the scrap heap when it is thought to be out of date and to replace it by another of the latest design, embodying the results of experience and acquired progress. It is this condition of affairs joined to that "spirit of rivalry," as Campbell calls it, that makes it possible for the American to compete in European markets with subsidized products, the price of labor and transportation, all of which should apparently make such a thing impossible. G. L. F.

VALUE OF SUPERHEATING FOR STATIONARY PLANTS.

Societe belge d'Electriciens, March, vol. xx., p 93.

The article is a very complete and interesting study of the use of superheated steam. The elements of the observations have been supplied by a large number of experiments made by Messrs. Schroter and Vincotte with a tandem compound engine of 250 horse power. As a result of these tests the following laws have been formulated:

The actual saving due to superheating, or the reduction in steam consumption, is proportional to the amount of superheating; that is to say, to the excess of temperature of the steam as it enters the cylinders above that corresponding to that of saturation. It may be remarked, however, that this rule holds only for temperatures up to from 660 degrees to 710 degrees F., and that above these points the additional saving is inappreciable.

Steam jacketing has also been carefully studied.

With saturated steam, a jacket on the small cylinder effects a saving of 5 per cent. This saving diminishes with the use of superheated steam up to 480 degrees F. Beyond this the jacket causes a loss. As a result of a number of observations it appears that a saving is effected by a jacket on the large cylinder up to a temperature of 660 degrees F.

The saving of steam from superheating is not the one that should be considered. The true saving is that of the fuel, and here one is led to discuss the practical use of an independent superheater whose utilization of the heat of combustion is not usually very good. Various combinations of superheaters on boilers are cited with results that lead to the conclusion that a good deal of investigation is still needed before the final solution of the problem will be reached. For, as it is forcibly stated, the delicate point in the matter is not the engine, but the superheater.

With superheated steam it is of the utmost importance to look well to the jacketing of the piping and see to it that there are no bare surfaces. It is calculated that with an initial temperature of 575 degrees F. the fall in temperature is from .26 degree to .55 degree for each running foot of a well-jacketed pipe. For the same speed of flow, the larger the diameter of the pipe the less the cooling, because the surface exposed is less in proportion to the volume moving. On the other hand, it is desirable to give the steam as high a velocity of flow in the pipes as possible in order to avoid a prolonged contact with the metal. Owing to the lesser density of superheated steam, as compared with saturated, it can be given a velocity 30 per cent. in excess of that possible with the latter.

From the standpoint of practical operation there is no need to exaggerate the difficulties surrounding the use of superheated steam. It demands the use of proper lubricants, but they are already on the market; of metallic packing, and of steel piping, and not copper, so constructed that it has ample elasticity to compensate for all expansion and contraction.

G. L. F.

IMPROVED MANUFACTURE OF RIFLE BARRELS IN GREAT BRITAIN.

Mechanical Engineer, February 6, 1904.

For some time the Birmingham Small Arms Company have been experimenting, with the object of doing away with the method of hand "setting" gun barrels, and their experiments have terminated successfully. Although rifles have for a long time been made by machinery, the one thing which machines were unable to do was to produce a perfect barrel, and the barrel-setter remained an important person in the gun factory. On his skill of hand and keenness of eye depended the production of a barrel free from any inequalities of the interior surface, and therefore a perfect shooting weapon. There was a call for his services at almost every stage. First when the steel blank destined to become a barrel had been forged and was cold it passed on to the straightener, who with hammer and anvil effected the required adjustment. Then followed the drilling of the tube. This was formerly done from both ends simultaneously because of the slenderness of the drill in comparison to its length, and it may easily be imagined that under such a system a very trifling inaccuracy in the setting resulted in a failure to secure perfect alignment. If the drilling was not true—and very often it was not—the services of the barrel-setter again became necessary.

It often happened also that after rough-turning the tube had a crook which required further hammering to straighten it out. Nor did the trouble end there. The barrel had to be further turned until it was reduced to nearly the required dimensions, and then the bore had to be gradually enlarged. This was done with a reamer, and each stage of the enlargement was followed by more of the setter's delicate attentions, until at length a tube was produced as perfect as human skill could make it. Little wonder the barrel-setters were autocrats. Years of patient observation and application were necessary to qualify them for their important task, and their earnings were correspondingly large—these occasionally being as much as $50 a week, while in normal times the weekly wage was somewhere about $25. Apart from the expense, however, it was a cumbrous system, and, further, the experts were not satisfied with it, as however careful the setting might be the natural stress of the metal in the tube was altered by hammering, and it was liable to subsequent distortion under the influence of temperature such as was caused by rapid firing.

The search for a better method has involved considerable modifications in the earlier stages of the manufacture of the blank from which the rifle barrel is made. Instead of waiting for the forged rod, which is ultimately to be converted into a barrel, to cool before it is straightened, this operation is carried out in the smithy while the steel is red hot and sufficiently ductile to permit of modifications of shape without the introduction of serious stresses. Great care has also been bestowed upon the perfection of the machinery which deals with the blank. In a very large percentage of cases it is found that the first turning of the outer surface produces an absolutely true bar, and in the matter of drilling the company have made a distinct departure from the practice of some other firms. Instead of putting drills to work from each end toward the middle they drive straight through with one drill. In order to facilitate the cutting, a constant stream of oil is forced down a channel in the drill, which not only serves as a lubricant, but on the return journey washes back with it the metal fragments which the tool has cut away. Mr. A. H. M. Driver, the chief engineer to the company, and his assistant, Mr. G. Norman, are the joint patentees of various ingenious devices introduced at this stage, which materially increase the accuracy which the majority of the barrels show after undergoing this first drilling.

It is necessary, however, to inspect all of them, and in the old days this is where the barrel-setter's art would have come in. But the setters of the old school are all gone, and more scientific methods prevail. The barrels are placed in a sort of rack, which holds them tilted end up to the light. But the light is not permitted to stream in unobstructed, as was the case with the old method. It is admitted through a circular aperture, which produces a number of perfectly ring-shaped zones of light and shadow, and not a cone shadow, such as the old setter had to guide him. As the operator of the machine gazes down it, the barrel is given a spin, and now even a novice can tell whether the workmanship under examination has been true. If it is, the rings revolve concentrically; if it is not, then they revolve eccentrically. In the latter case there is no hammering to be done, but by the turn of a screw the machine puts on the pressure required to rectify the irregularity, not in one spot, as the hammer blow would do, but evenly over a fairly large portion of the barrel. By this method, it is claimed, the barrel is not injured, and is consequently unlikely to suffer deflection from truth in the final reaming and turning.

In addition to the greater accuracy secured by the new method of testing and setting, the process has resulted in a considerable saving of time and expense. Under the old conditions it was not uncommon for the barrels to undergo seven or eight or even ten settings by the hammer, and the time thus occupied was considerable. Now, however, the process occupies 50 per cent. less time. In addition, as the drilling and boring machines are automatic, two or three can be placed under the charge of one person, while the setting machine has enabled the operations which were performed by the highly-paid setters of the old school to be done by ordinary machine hands. The process of straightening can also be successfully done on the barrels of the sporting shot-gun.

PNEUMATIC TOOLS FOR RAILROAD WORK.

Extract from Paper read by Mr. Thomas Alcorn before the New England Railroad Club, December 8, 1903.

The pneumatic hammer is the most widely used and best known pneumatic appliance in shop service, employed for chipping, calking, beading flues and riveting. Averaging 10 to 13 pounds in weight and operating at a speed of 1,100 to 2,000 blows per minute, it may be readily calculated how powerful an agent this tool becomes in the hands of a competent operator—and competence is readily acquired by an ordinary grade of labor, a peculiarly advantageous feature applicable to all air tools. The value of the hammer as a saver of time and labor is so universally conceded that the time has passed where it was deemed necessary to submit comparative figures, especially as much depends upon the conditions of operation and the efficiency of the air plant; but we may say, briefly, that one man with a pneumatic hammer, in chipping, etc., will do as much as three to four men working by hand. A ⅜-inch chip has been removed by one of these hammers from a boiler plate ½ inch thick at the rate of 7 inches in 58 seconds.

In addition to the chipping of metals, calking of seams and joints, the hammer is naturally utilized for a wide variety of purposes requiring a rapid percussive blow—from the dentist's mallet to the driving of drift bolts. Among special uses for the hammer of particular interest to railroads may be mentioned the driving of spikes and removing scale from locomotive crown sheets. For spike driving the ordinary long-stroke hammer held by the hand is provided, with a set suited to the spike head, but for the removal of scale from crown sheets the hammer (or jam riveter, as it is technically called in this instance) is adjusted between grate and crown sheet by means of a pipe extension, and in the stationary position so provided quickly performs the work by the rapid succession of blows which it strikes. In riveting on a standard fire-box leg containing 253 ¾-inch rivets, a long-stroke hammer will drive all of them in 9 hours at a cost of 48 cents per hour, or a total for the entire fire box of $4.32. This same job by hand work will take 15 hours at a cost of 73 cents per hour, or a total for the entire job by hand of $10.95; or if the same job was done by hand-snapping the rivets, it would take 12 hours at a cost of 63 cents per hour, or a total cost of $7.56. Thus it will be seen that a saving is made on this particular job of $6.63 over the hand-driven rivets, or $3.23 over the hand-snapped rivets. In another instance 1¼-inch rivets were driven in a boiler which stood 360 pounds pressure, with a pneumatic hand hammer, at about one-third the cost of old methods.

The air drill (or reamer), next to the percussive hammer, is the most widely known pneumatic appliance, and has an extensive range of utility. Almost numberless are the shop operations the labor and time in performing which have been reduced by this portable, compact pneumatic motor, that will fit in almost any space, employing an angle gear if necessary, and which is always ready at the instant. Easy to hold and guide, wonderfully lightening arduous tasks, it is not surprising that this tool does not share the customary antipathy of the workman to labor-saving devices. Among special uses for the drill motor is its adaptation as a casting cleaner, portable emery wheel, polisher, and for driving cylinder boring bars, valve facing machines, motor hoists, operating turntables, jib cranes and elevators.

In the car shops, working in wood, the pneumatic drill, running at a higher speed than the one used on metal and weighing from 10 to 25 pounds, will bore a 2½-inch hole through 5 inches of oak in less than 20 seconds, an excellent record, as all will agree who have ever attempted to bore a 2½-inch hole in oak. The foreman of car construction of one of the leading railroad shops in the country states that by the use of a wood boring machine his men are able to bore all the holes necessary in the erection of a standard coal car, 192 in number, in 15 minutes. Allowing 3 minutes for shifting the air supply from one side of the car to the other, this leaves a net period of 12 minutes for the boring of the holes. This he considers a remarkable performance, and so far in advance of hand work as to make comparison out of the question.

One of the newest pneumatic devices, with which doubtless many are not familiar, is the hydro-pneumatic wheel press, consisting of an air cylinder operated in conjunction with an oil-filled piston carrying tail rod or intensifier, the arrangement affording an unusual effect in power concentration. It is not the intention to enter here into a detailed description of this device, which must be seen to be appreciated, but its value in any form of work and in any position where an extraordinary amount of power must be exerted in a quick operation is unique. For removing crank pins, or as a punch, or for hoisting, or as a car jack, this machine covers a wide range of usefulness. Occupying less space and working with a considerably less consumption of power, this device represents a marked advance over any form of tool heretofore employed for the purpose.

RE THE WATCHMAN'S WATCH.

Extract from Paper read by Mr. A. Newman, December 8, 1903, before the Annual Meeting of the Field Club of the Illinois Fire Underwriters' Association in Chicago.

"About fifty years ago one Buerk, a manufacturer of high-grade clock movements and other horological instruments, living in a small village in the Black forest of Germany, invented what is known as the portable watchman's clock. This man Buerk was a genius, the more so that he had no intention to make a watchman's clock for the market, but invented this device for the sole purpose of controlling his own night watchman. He had a watchman whose name was Fritz Traumer, a very suggestive one and no misnomer, for Unser Fritz would dream the night away instead of patrolling his beat. So Buerk took it into his head to devise ways and means to checkmate the peaceful occupation of his guardian by putting one of his small movements in a locked brass case, placing upon the center or hour wheel a hand and a cylinder or drum so arranged as to travel with the hour hand. Upon the periphery of the drum he fastened a paper tape properly ruled and marked as to hours and fractions of hours and cross lines to denote the stations. Opposite the correct time was fastened a forked spring with pointed prongs at its outer end. Each prong stood opposite one of the rulings of the paper tape. At the stations to be visited he placed chains about twelve inches in length, and upon the end of each chain a key was fastened. The watchman carried the clock to the stations, inserted the keys, each of which, when turned, would raise one of the prongs and press the point of the same into the paper slip.

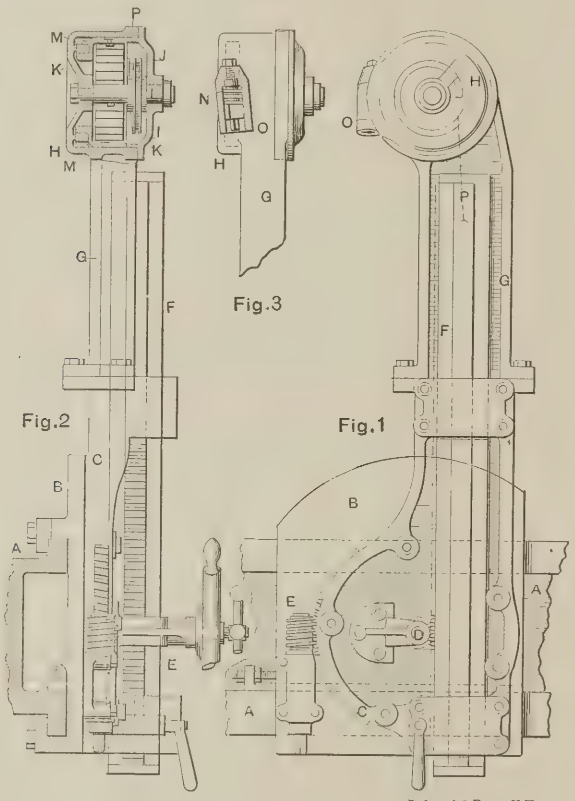
"Each key striking a different prong, would naturally cause a prick mark to be made on the different lines in the paper slip. The little village made merry over the piece of ingenuity of Herr Buerk, and Fritz, for the time being was the butt and laughing stock of the community, but the host of the Wurtshaus grieved with Fritz, for the keg did not run dry quite so fast as in the days before the telltale clock was installed in the Buerk plant, and Fritz allowed his dreams to run in different directions and became a somnambulist while he was doing his beat, and as he was walking and dreaming in this aggressive fashion he came to the conclusion that Buerk did not know much, after all. The chain was very easily opened with a pair of plyers, the keys taken off and carried to the Wurtshaus, and mine host should be happy again. In the course of time Buerk naturally awoke to the fact that his place was not well watched, and discovered the method by which the watchman circumvented his own craftiness. So he set to work upon a scheme to beat the watchman's game. This he did by making a safety link chain which could not be taken apart after having been put together without taking each link from the further end of the key, and as the further end link was fastened at the station by screws and seals, the watchman was unable to carry away the keys. This safety chain is very well known and is used for almost everything that a chain can be adapted for. It still bears the name of 'safety chain' and derived its name from its first use. Buerk never knew the value of this chain in any other way than as an auxiliary for his watchman's clock apparatus. This only goes to show how an inventor's mind, starting off in a certain groove, will get so fascinated with his work, looking neither to the right nor left, and thus miss the tide at the flood. The safety chain would have made Buerk one of the wealthiest men in Germany had he patented it, but Buerk felt too much interested in the watchman's watch, and immediately placed them on the market. He reaped a nice income from their sale and left his family in good circumstances."

SPRING COUNTERBALANCE FOR THE BARS OF BORING AND TURNING MILLS.

Mechanical Engineer, February 6, 1904, p. 177.

This improvement, proposed by Mr. J. E. Mathewson, of Brodheath, near Manchester, relates to the counterbalancing of the tool bars of boring and turning mills. The usual practice in counterbalancing these bars is to do it by means of weights, chains and pulleys, but Mr. Mathewson proposes to make each head self-contained and to balance the weight of the bar by a coiled spring mounted in a suitable box at the top of the slide which is extended for this purpose.

Fig. 1 is a front elevation of the improved ram or tool holder, Fig. 2 is a side elevation of the same partly in section, and Fig. 3 is an outside view partly in section. *A* indicates the closs slide of the machine, *B* is the saddle and *C* is the ram frame, which is pivoted at *D* to the saddle. This frame is provided with teeth on its outer edge, and by means of the worm *E* the frame *C* may be rocked on its pivot *D* to any angle required by the workman. *F* is the ram or tool holder which slides in suitable guides in the frame *C*. To the top of the frame *C* is adapted a support G, which carries at its upper end a box *H* containing a coiled spring *I*, a fusee *J* or equivalent equalizing device, and bearings for an axle *L*. *K* is a ring which is capable of rotating in the box *H*. Outside, on one edge, this ring *K* is provided with external teeth *M*, with which gears a worm *N* contained in a suitable box *O* secured to the side of the box *H*. This worm is capable of being rotated by means of a key or otherwise. One end of the spring *I* is attached to the ring *K*, and the other end to the axle *L*, on which is also keyed the fusee *J*. To the fusee *J* is attached one end of a flexible connection, such as a cord or chain *P*, the other end being attached to the ram *F*. The tension of the spring is regulated according to the weight of the ram by rotating the ring *K* by means of the worm *N* and the external teeth *M*, the worm serving to retain the ring in the position in which it is set.



Industrial Press, N.Y.

PATENT LAW ADMINISTRATION.

In Switzerland, where we may look for the most enlightened laws and policy in such things, the patent laws were for a time abrogated, and again restored on nearly their former basis, so that the equity and expediency of such grants can scarcely be called in question. There is also the further fact that British laws, from which the system originated 280 years ago, have changed but little in all that time. From England the system of patent grants for inventions spread widely over the world, our own dating back something more than a century, the present indices reaching to 1790. It is an interesting study to examine the development of this patent system and the impediments which had to be overcome because of the paucity of technical knowledge and skill required to administer such a bureau in a new country, where science and the technical arts had a narrow foothold until comparatively recent times.

Down to 1870 or later than that, each inventor had to supply a model of his invention, in order to enable the officers of the Patent Office to understand its nature and its manner of operation. Not only this, but the drawings supplied had to conform to the model, and, as models were naturally crude, the result of this can be imagined. No other country, that I am aware of, except Canada, adopted such a feature, but in Canada the drawing and model were not required to correspond, so the model happily dropped out, though a little later than in this country. This method, which called out a good deal of ridicule in other countries, has left us a legacy of useless lumber, which still occupies a good deal of room in the cramped space where the Patent Office work is carried on. Some of these models have interest historically and some of them are well made, but destruction would be a proper treatment for three-fourths of the whole.

The operation of the patent laws went on with measurable uniformity in different countries until within a few years past, when the German Bureau initiated a reform that will no doubt extend to other countries where technical knowledge is sufficiently advanced to permit such a system. This change is fundamental in its nature, but not very easy to explain in a popular way. It consists in a measure of novelty and utility on grounds almost the reverse of present practice in this country. Our laws permit or grant patents on the means or agents of production only, that is, on contrivances or discoveries that produce results; and particularly bar patents on principles or on modes of operating. This, it will be seen, opens the door for endless patents on nearly the same thing, with slight differences that often turn upon mere phrases of speech.

The German government grants patents on results, or, in their terms, on "new technical results," paying but little attention to means or implements. Claims to express compendiously the subject matter of an invention are limited to one that must involve what is called a "unitary concept." Other claims may be added, not more than three, explanatory of the first. This plainly involves a complete change of system.

It would be an enormous innovation in this country for our astute patent agents, who can write twenty permutation claims on a nutcracker, but it is an advance to a higher plane, is logical and must commend itself to all who will analyze the true spirit and intent of patent grants for inventions. This juggling system of "permutation claims" is a distinguishing feature of modern practice in this country. It is a device that had its origin with patent agents, and because the claims in American patents were construed separately and independently. It is the reverse in England, where a patent falls with each and any of its claims; and in France, where until very recently, a patent required no claim at all separate from the body of the specification. This latter system permitted full discretion to the courts, and this discretion, I am glad to say, has been seldom abused. Our own courts have to deal with words and cunningly devised phrases instead of the essence, nature and scope of an invention, and, having a dread of subjects they cannot possibly understand beyond a construction of terms, the justices are apt to follow each other in their decisions on any issue. This was the case in the celebrated

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Abstract of paper read by Mr. John Richards before the Technical Society of the Pacific Coast, November 6, 1903, and published in the Association of Engineering Societies' Proceedings.

Woodworth patent suits early in the last century, when there were twenty-two suits at law over the invention of a "combination of feeding rollers and rotary cutters," which invention was embodied in the British patent of Bentham, 1793.

I am recounting these features of practice for two reasons: First, in order to show how difficult it is to administer the patent laws, and especially procedure in the Patent Office; and, secondly, to invite comment on some means of attaining a more intelligent and just procedure in that department.

The statute law relating to patents is printed on 32 small pages containing about 15,000 words, and is, in itself, quite simple and understandable; but this law is supplemented by endless decisions that attempt to fit the application of these laws to the circumstances of industrial inventions, and it is doubtful whether any human power could codify this maze and bring it into a harmonious relation with the arts. The "Rules of Procedure," 214 in number, emanating from the Commissioners of Patents and their advisers, is a more-extensive matter than the law, occupying 100 printed pages and about 47,000 words, much of which should be embraced in the statutes. These rules are intended for the instruction and guidance of the examiners and patent attorneys. They are often changed and extended to meet the constantly recurring problems that arise in an attempt to fit laws and administrative rules to science and the arts, which is, in the nature of things, impossible.

This impediment is fundamental and perhaps insuperable. The two things cannot be assimilated. Science and the arts are computable and exact. They deal with definite dimensions, fixed natural laws and skill, the latter meaning a personal recognition and acquaintance with these qualities, or quantities, and with the modes of their operation. Statute law is inexact, uncertain and mutable. It does not deal with dimensions or exact quantities of any kind; not even, except in an indirect way, with modes of operation. One may read through a law treatise, even on patent law, and not find in it a single thing that has a base in anything exact and proved, except, perhaps, a chemical formula. Men skilled in statute laws are seldom or never qualified to deal with the technicalities of the industrial arts, and, consequently, not capable of determining the nature, scope and relations of inventions.

Conversely, those skilled in the arts and accustomed to the exact results of science are apt to look with indifference and suspicion on the unstable laws and procedure relating to patents for inventions. The basis for this work must be facts, measurable and computable; things must correlate, must have constant sequence and must be uniform. Law and the practice of law are none of these things, but are arbitrary, uncertain and frequently illogical. It is not easy to make the difficulties of administration clear, but your own consideration of them will, no doubt, confirm the fact that neither this nor any other government has resources from which to draw officers to administer a patent bureau according to the spirit and intent of the laws.

Germany, which established excellent and numerous technical schools about 50 years ago, is at this time nearer than other countries to providing a corps of officers competent to pass upon and award patents for inventions. These technical schools had no marked influence over the industries of the country for 30 years or more, but now we can see their effect in many ways. In Saxony alone there are 287 industrial schools. The chemical industry will show the influence of this kind of training. In Germany there are more than 6,000 establishments making chemical products, employing 135,000 workmen. One of these, at Manheim, which I have seen, employs 6,000 workmen and 148 chemists, besides the clerical force. With few natural resources for chemical products, Germany managed to send into this country last year $14,000,000 worth of such manufactures.

Under such circumstances, where there are thousands of qualified men available to conduct this department in a patent bureau, we should naturally look for good practice; and, as I have before pointed out, their system is likely to produce imitation in other countries. It is likely that an impediment to this system will be found in its paternal nature. The law provides that each patent granted must include an "invention," and, as no law can define what an invention is, this point is left to the decision of the officers of the bureau at Berlin, qualified by the provision before named, that an invention must produce a new "technical result" and consist of a "unitary concept." This is vague, but is as far as law can go. It reaches the point where personal knowledge of the arts must begin; in other words it is the point where technical knowledge and impartial administration must take up the work, and brings us to what we call "procedure," in which a German officer is supposed to ignore nationality, forego his prejudices and act impartially. Time will show whether this be possible.

In this country the enormous activity of industrial production furnishes a field that absorbs the technically trained people, and few are available for the Patent Bureau. On the contrary, the legal profession is overflowing and aggressive, and, as patents for inventions are commonly understood as a matter of law instead of technical discrimination, the result is confusion. An examiner-in-chief, of which there are three who sit as a board of appeal in contested cases, receives the sum of $3,000 a year; a principal examiner, the head of a division, gets $2,500; a first assistant examiner, $1,800 a year, and from this the salaries run down to $1,200 a year for fourth assistant examiners. There are 200 officers who come under the head of examiners, and in all between 700 and 800 people employed by the bureau, a large proportion of whom seem to come from the New England States.

It is an amazing example of routine work, done by rule and apparently without personal discretion—by rules that have grown out of the conduct of the office and the circumstances of procedure. Changes—even the slightest—are ventured upon with timidity, and, while it is easy to discern much that seems illogical and wrong, it would be hard to see how any successful change can be made without starting at the very beginning with a new law relating to patents for inventions.

The functions of examination and rejection are the salient features of our patent system. The rejection of a patent is in its nature a paternal act, wherein the government assumes a function that properly belongs to the citizen. The applicant is not permitted to use his own judgment as to what he can maintain and defend, but is taken care of, so to speak, and instructed as to what he shall have the privilege of maintaining, by the judgment of an officer who can destroy but cannot confirm. This is paternalism and establishes a common conclusion in the minds of applicants, and, indeed, in the minds of all except those who have studied the patent laws, that they are to receive with a patent a confirmed right. Patent agents all over the country will bear evidence to the existence of this opinion among their clients, who look upon the examiners as holding in their power a favor to be bestowed or withheld. "Get all you can" are the instructions, but these same people are generally very cautious respecting their claims in other countries, where personal responsibility is the same. It may at first thought seem a strange proposition that the rejection of patents should increase the number and lower the character of applications, but I am satisfied that it does so. Thousands of applications are made that would never appear if the applicant and his attorney were made responsible, as in England, for the scope and novelty of inventions as presented to the bureau. I judge of this matter by the fact that patents are more respected there than here, and are seldom repeated and more often sustained in the law courts.

A primary examiner in our Patent Bureau, instead of acting in what may be called a professional capacity, performs routine duties in which his individuality is usually eliminated. He does not even sign his decisions and has no power to amend them; no matter how mistaken they may be they must go permanently into the record. But, strangest of all, he exercises a "triple function," so to speak, being a whole tribunal in himself, acting as witness, counsel and judge. He prepares the evidence, presents it as attorney for the government as against the client and then passes judicially upon his own finding by deciding whether the applicant shall or shall not have the privilege of defending his claims in the law court. These duties, instead of being professional and advisory, are arbitrary; they consequently fail to command the confidence of inventors and put the bureau in a false position before the country.

I am inclined to think that our patent system, or the manner of its administration, has, in some cases, exercised a restraining influence on certain arts. As a case in illustration: Among those interested in the subject it is a matter of common knowledge that inventions pertaining to hydraulics have for many years past met with scant encouragement in the American Patent Office, and that, as an example, our water-wheel practice, a very extensive interest, is in certain types distinctly behind that of France, England, Germany and Hungary, a fact that appeared when the Niagara Commission met at London in 1890 to consider water wheels for the Niagara Falls scheme. American makers presented no plans that the commission considered, or even mentioned, in their report, except one tender from San Francisco for tangential wheels, which I had the honor to prepare. Pressure turbine practice in this country, except as to one type, the centripetal or central-discharge one, came from France, and the best examples in use here were made under the patents of Fourneyron and Jonval, while the Girard type, that was best suited for use at Niagara and for high heads, was not until 1893 made in this country at all, and was then so badly made as to fail, so that no impulsive-acting wheels of any kind were made, down to the evolution of the tangential type on this coast.

How a country where so much water power is employed under all kinds of heads and conditions could go on until a few years ago without any manufacture of the type of water wheels known as the Girard class of unfilled or partial turbines (one of the most common in Europe) will appear if we examine the history of some early inventions here.

In February, 1853, fifty years ago, Mr. Jearum Atkins, of Illinois, I think, filed in the Patent Office at Washington an application for an improvement in water wheels of the unfilled or impulse type, and in his specification set forth, in the form of a well-written treatise, the principles on which his wheels operated. This application was promptly "rejected." No unfilled turbine had been seen before, and Mr. Atkins, being a poor man without resources, and an invalid besides, was not able to prosecute his case by appeal or otherwise, and, as the patent could not issue because of "rejection," he was unable to work his invention, except to make one very successful wheel; so the invention was strangled, so to speak, by rejection.

About 1860, seven years later, Messrs, Escher, Wyss & Co., of Zurich, Switzerland, began making water wheels of the same type, and the practice rapidly extended all over Europe, especially in France and Switzerland, and, as I have remarked, came back to this country in 1890 through the plans of the water wheels at Niagara, which were made from drawings furnished by Messrs. Faesch & Picard, of Geneva, Switzerland, who, with four or more other European firms, tendered full designs for the construction of these wheels.

In 1875 Mr. Atkins' invention was somehow resuscitated at the Patent Office in this country and a patent was issued to him, but too late to do him any good or to aid in founding the manufacture here. Mr. Atkins, when I last heard from him, was living at an advanced age in the Mechanics' Home in Philadelphia. He was an original inventor, perhaps the first to discover and explain what are called impulse or open-turbine wheels, in which the discharge vents are larger than the inlet ways, and was the first, in this country at least, to lay down in a clear manner the principles involved in this kind of water wheels, which include the tangential type extensively made and used on this coast.

Suppose the patent of Mr. Atkins had been issued in 1853, even with all the objections that were urged against it in the Patent Office, no one will doubt that the inventor's representations and his better understanding of the subject would, in either a business way or even in suits at law to defend his invention, have been quite sufficient to work and sustain his patent; and if this had been done, this country would have reaped a great reward from the invention. It is not contended that the examiner should have known that a turbine water wheel would operate when not filled and when the discharge passages had double the area of the inlet ways. A recorded opinion to that effect would by no means have destroyed Atkins' patent if it had been issued at his request, but "rejection" took away his power of utilizing the invention and destroyed it, whereas it is quite sure the courts would have sustained his claims, notwithstanding the action of the Patent Office.

I could go on and show that in centrifugal pumps, gas engines and other important manufactures procedure in the Patent Office has hindered progress. Just at this time I have failed to have a distinction made between impulsive-acting and pressure fluid machines operating by steam. Both types seem to be in one class, although their manner of operating is essentially different. It is like the old problem of 1853, or, rather, is the same problem over again, and the result is that there is not a manufacture of impulsive-acting steam engines in this country that is not either an imitation of European practice or paying tribute to foreign inventors. The first successful engines of this type, of which I have any knowledge, were made about eighty years ago by William Avery, of Syracuse, N. Y., an uncle of Prof. John E. Sweet, who made fifty or more, and, as I have just remarked, there is not at this time a separate division in which these engines could be classed in the Patent Office.

In 1895 a distinct invention in ignition apparatus for gas engines was made by Mr. George E. Hoyt, of San Francisco, in which the "time function" was regulated by resistance and distance of flow of the gases into a tube having a small bore about one-thirtieth of an inch in diameter. This invention was presented and persistently prosecuted before the Patent Office for two years. The inventor sent to the office tubes 5 inches and others 30 inches long, with affidavits to show that both had been on the same engines under the same conditions, and that it was the contracted bore, resistance and consequent velocity of flow into the tubes that determined the time point of ignition.

The claims were rejected by the primary examiner on irrelevant references, and by the examiners-in-chief, and was abandoned because the parties in interest concluded, and yet believe, that the invention was opposed on technicalities and not considered on its merits as an invention. There is no intention to disparage or underrate the eminent attainments of a large number of officers in the bureau, but even these are bound by a routine of rules and precedents that prevent personal and responsible action in technical matters. They are bound to consider terms and forms of speech that are purposely made entangling and obscure, and not the essential facts.

I do not feel qualified to suggest a remedy for the features of our patent system that have been criticised, but strongly suspect that the German laws and procedure are a distinct advance in some of the objects to be attained by a patent system. I believe that the number of patents granted in this country, about half a million a year, could be well reduced to one-third as many by the requirement that each patent should relate to a new "technical result," and not a means alone; that patent attorneys should not be admitted to registry or to practice in office procedure unless competent and qualified, as in other professions; that the actions of the primary examiners, which are now a part of the permanent record, should, with amendments, be printed with each patent; that the power of final rejection be taken away from the primary examiners and exercised by different officers, capable of judging impartially of new technical results; that the appeal of tribunals of the bureau, now wholly inadequate, should have more time and facilities for their actions; that the salaries of the chief and first-class examiners should be doubled, so as to command higher technical qualifications for this intricate and responsible work.

* * *

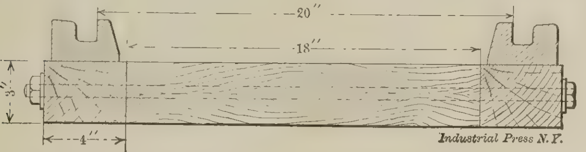
We never look forward with any degree of expectancy to the time when an active trade shall have been developed in drilled, bored, tapped or reamed holes *per se*, but evidently the hole-making industry has reached a state of development in another industry quite surprising since we note in a daily journal the advertisement of a buttonhole factory for sale in Rochester.

MACHINE SHOP EQUIPMENT.—7.

SHOP TRANSPORTATION EQUIPMENT.

OSCAR E. PERRIGO.

The question of the transportation of stock and material from the point of its receipt from outside sources to the various departments where it is to begin its regular transit from the raw material to the finished product, of transferring this material from one department to another during its progress through the shops, and of its final transit from the department where it is finished to the storehouse, for safe keeping or for shipping to customers, is an important matter. For if closely followed through all its various stages, and the expenses accurately kept, as to the capital involved in the appliances necessary, the proper maintenance of these facilities in good working condition, and the labor necessary for their successful operation, it would appear to be a far larger item of expense in the general account than would usually be supposed from a superficial consideration of the question.



Industrial Press N.Y.

Fig. 3. Cross-section of Straight Track when Laid.

This is a matter upon which careful planning is needed in all its bearings, as any saving in this respect, while still rendering good service, is an actual saving, and unlike the reduction of the cost in building a machine for the market, is not liable to effect a deterioration of the real quality or value of the product. This does not mean that the service can, or should be made inefficient in order to avoid expense, but rather that it should be well planned, well administered, prompt and efficient in every way, yet without a useless appliance or an unnecessary man employed in it. For instance, the progress of the work through the different departments should be so arranged that, as far as possible, it may be really progressive from the raw material to the finished product, with as little "retrograde movement" as may be. In this way a considerable percentage of the work of transporting materials and stock in progress may be saved, rendering a less extensive equipment of cars, trucks, etc., necessary, as well as a smaller force of employees for handling them.

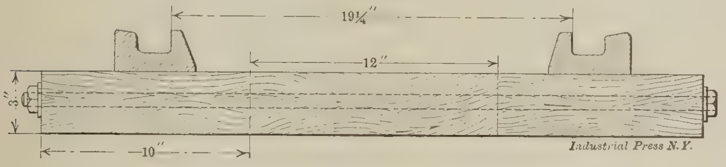


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Fig. 4. Cross-section of Curved Track when Laid.

In arranging the different departments of the plant here shown due consideration was given to this matter and they were carefully planned with this end in view, as will be more fully pointed out in the articles on shop management, which will succeed this series.

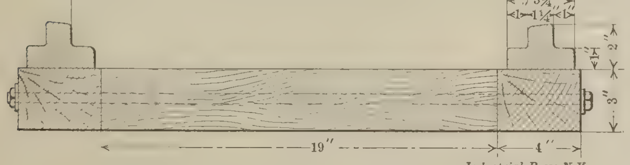

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Fig. 7. Cross-section of Straight Yard Track.

In the list of appliances that may be classed as transportation facilities, we may mention traveling cranes, overhead trolleys, shop cars on tracks, cars on yard tracks, hand trucks, and small tool conveyors. Of these, the traveling cranes may be those propelled by a shaft running the entire distance of their travel, by those carrying an electric motor for their propulsion, and those of small capacity worked by hand, with a chain reaching down near the floor. Again, as to lifting power, they are operated by the shaft above-mentioned, by a motor, or by chain blocks with the usual differential chain wheels or other similar device.

Overhead trolleys running on I-beams may have a small motor mounted upon them furnishing the power for their propulsion as well as for their lifting power. Frequently those of moderate capacity are pulled along by hand, and the loads lifted by chain blocks operated by hand. These trolley tracks are so constructed that they can be put up in straight lines, curves, switches, crossings, etc., which render them very convenient for light work, and they occupy but little room overhead, and none at all on the floor. In some cases, however, existing overhead obstacles such as shafting, belting, countershafts, etc., preclude the use of either the overhead trolley or the traveling crane; in others the weights are not sufficient to demand the expense of a traveling crane; in still other locations several traveling cranes would be required to cover the space to be operated in. Then there are other situations in which lack of height prevents the use of the overhead trolley system.

Shop tracks for the accommodation of cars of the usual size, say, 34 inches wide and 5 feet long, will be of the same gage as the yard tracks, or about 20 inches, so that the shop cars or heavier and larger yard cars may be used on the whole system. These cars may be propelled by small electric motors in the form of an electric locomotive, which is simply a car fitted with two motors operated by a storage battery, but more often they are pushed about by hand, particularly when loaded with less than 2 tons weight.

A balance crane may be erected on a car for yard or shop use, and may by this arrangement be capable of picking up and carrying a load up to a ton or two. It is very useful in locations where power for loading is not available.

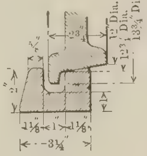


Fig. 5.

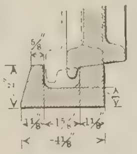
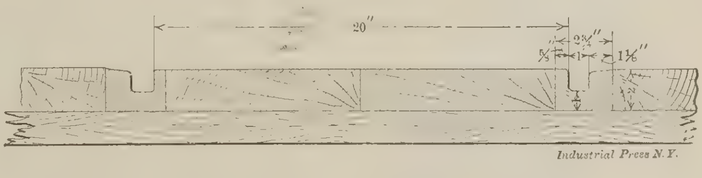


Fig. 6.

Four-wheeled shop trucks with the front axle pivoted and handled by a tongue, should have their wheels so constructed and located as to properly run upon the shop tracks as well as upon the floors.

The Franklin portable crane is simply a small jib crane on wheels, which may be moved about the shop as easily as a hand truck. Its capacity is from one and a half to three tons. It readily lifts and holds the load at any point so that it can be wheeled to any desired location. It is now made also with a gasoline motor, or an electric motor run by a storage battery for both propulsion by traction wheels and the power for lifting—making a very complete and portable power crane for many ordinary shop purposes. It will be found a very convenient and useful addition to the shop equipment.



Industrial Press N.Y.

Fig. 8. Cross-section of Straight Shop Track.

The traveling cranes provided for in the various departments do not seem to need any detailed description. There are many excellent ones in the market and they should be selected with a view to the special requirements of each case.

In considering a system of tracks for yards, and the system for the construction of cars for use upon these tracks, the Hunt system is probably the best and most complete of anything in the market, particularly when heavy work is to be undertaken. However, for moderate loads a more economical method of construction may be adopted, and one that may be built in the shops without a great outlay for patterns or spe-

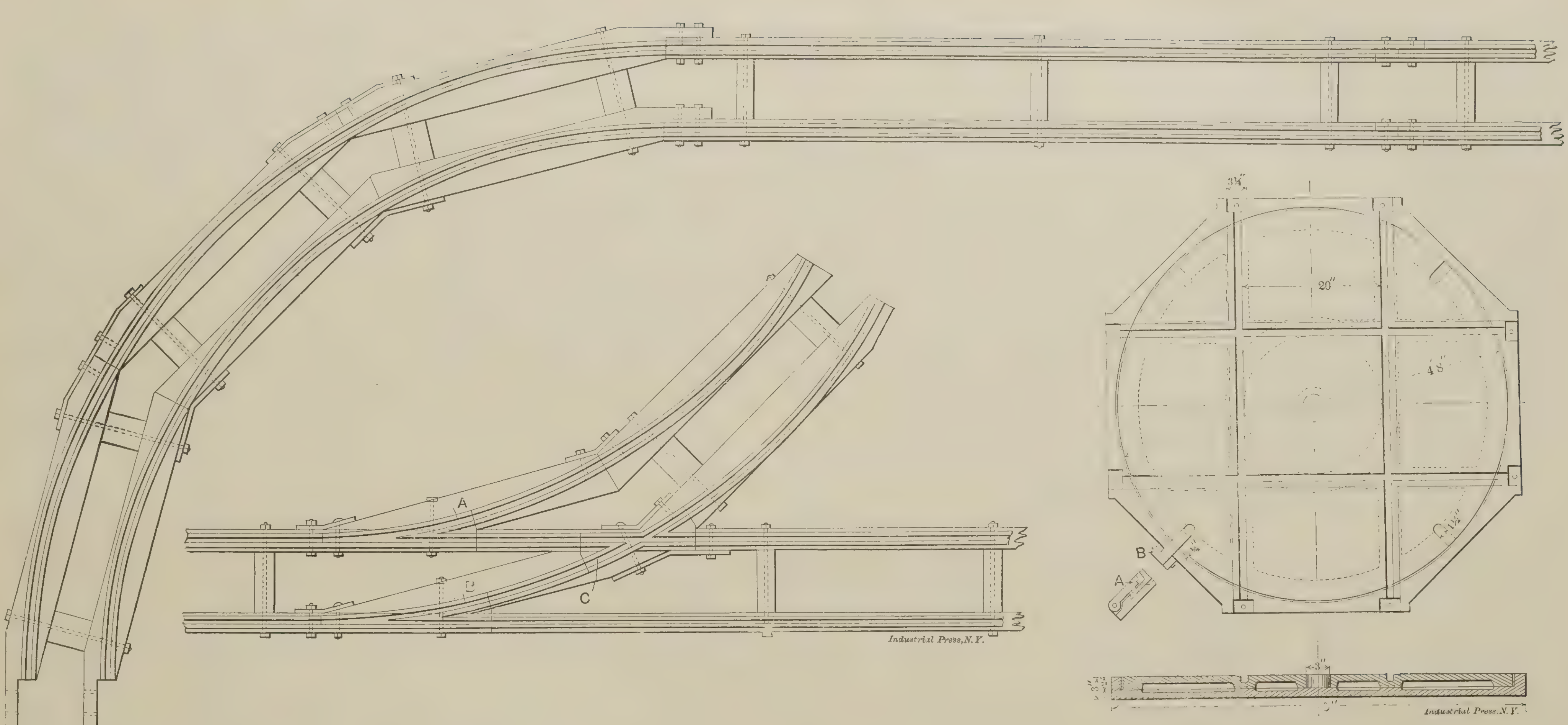


Fig. 1. Plan of Curve and Straight Track showing Method of Joining.

Fig. 2. Plan of Switch showing Method of Securing Supporting Timbers.

Fig. 9. Plan and Cross-section of Turntable.

cial tools. Metallic ties are no doubt the ideal method for laying track on the ground when steel rolled track is used. Yet a cast-iron track, properly constructed and properly supported will be found very practical for every-day service in a plant of such a character as the one under consideration. Again, where track is to be laid on upper floors it would not seem advisable to use the heavy plate track made of cast iron on account of its considerable weight. Much of this is not necessary for the purpose, particularly when moderate loads are to be transported, as is usual with work done on the floors above the first; and all excess of weight is not only detrimental, as unnecessarily loading down the building, but adds needlessly to the expense. In fact the principal requirements of a floor track would seem to be these: First, it should be on a level with the top of the floor, so as not to offer any obstruction to the workmen going from place to place, or to the passage of hand trucks over it. Second, it should be of such moderate weight that it may be laid down on any floor of the building without overweighting it. Third, it should be of such simple construction that an ordinary mechanic may build one, put it in operation and repair it. Fourth, it should be so designed that cars having a fixed wheel base may readily run around its curves without undue friction. Fifth, it should be of such depth that it may be easily laid down by cutting through the usual two-inch plank floor of the ordinary machine shop, or laying the track first, in the case of a new shop being erected, and fitting the floor around it.

A track designed and constructed in conformity with these conditions is illustrated in the drawings accompanying this article. Fig. 1 is a plan of a section of straight track joined and secured to a 90-degree curve. Fig. 2 is a section of straight track in connection with a left-hand switch. Fig. 3 is a cross-section of the straight track, on an enlarged scale. Fig. 4 is a cross-section of curved track, also on an enlarged scale. All of these views show the track and its supporting timbers as arranged and laid in the shop yards. Fig. 5 is a cross-section on a still larger scale, showing the relation of the straight track and a portion of the rim of a car wheel. Fig. 6 is a similar section showing the position of the wheel on the outer rail of a curve.

Upon a straight track it is a simple matter to construct wheels or track that will run properly and work freely without undue friction or grinding upon the edges of the rails. When the curves are considered quite a different problem presents itself. The outer rail upon a curve being considerably longer than the inner rail, means must be provided for compensating for this difference so that there may be no slipping of either wheel of the car when passing around the curve, in the case of the usual four-wheeled cars whose wheel axles are journaled in fixed boxes. To provide for this condition the groove in the track is considerably widened, whereby the wheel flange may have ample space to run from side to side. The wheel is constructed with an inclined face, representing a short section of a cone. It is considerably wider than the portion of the track upon which it runs, as will be seen by referring to Figs. 5 and 6. The action of this arrangement is as follows: When running on a straight track the position of the wheels on the track will naturally be midway, in consequence of the reversed position of the inclined tread of the wheels. When the car arrives at a curve the natural tendency is toward the outer rail. This tendency will throw the outer wheel up on its largest diameter and at the same time bring the bearing of the wheel on the inside of the curve to its smallest diameter. This variation of diameters will be sufficient to compensate for the increased length of the rail on the outer side of the curve and the car will run smoothly around it. The difference between the width of the groove in the straight track and that on the curves is arranged for by narrowing the groove in the curved track to the proper width in the final 8 or 10 inches from the end where it joins the straight track. The dimensions of the track are given in Figs. 5 and 6. All curves are of 12 feet radius to the inside rail of the curve, and it would be better to make them 14 feet if possible, as the longer the radius the easier the cars will go around the curves, no matter what system of construction of cars is used. For switches the plan will be as shown in Fig. 2. Special castings are constructed as shown at *A*, *B*, and *C*, and to these the curved and the straight track will be joined as shown. Of course, these special castings must be made for right and left switches, necessitating two patterns of each piece. A shifting tongue to the switch need not necessarily be provided for cars carrying light loads, as it is a comparatively easy matter to guide them as desired. These yard tracks are laid upon timbers which are bedded in flush with the top of the ground. For the straight track they are 3 x 4 inches and secured, as shown, by cross pieces and through-and-through bolts ⅝ inch in diameter. For the curves 3 x 10-inch timbers are needed, and they are similarly fastened. In attaching the straight sections to each other the timbers are lapped and bolted as shown. On the curves, switches and similar places, iron straps fastened by bolts or lag screws are used to connect them, as shown in the drawing.

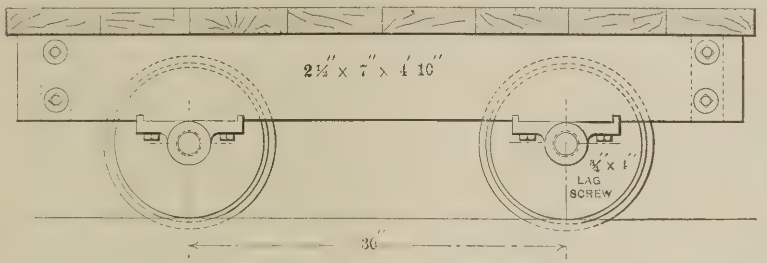


Fig. 10. Side Elevation of Tram Car.

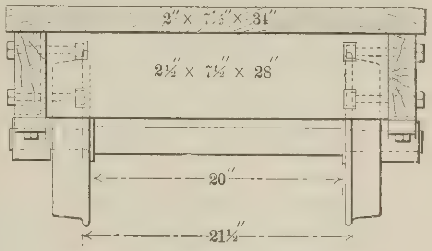


Fig. 11. End Elevation of Tram Car.

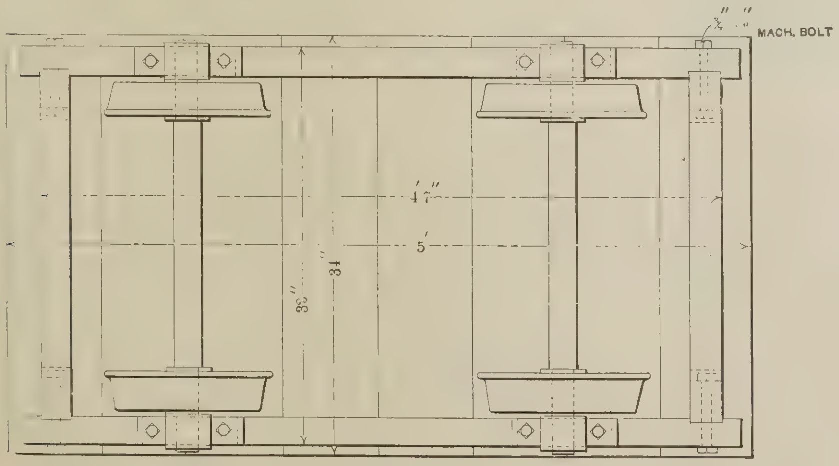
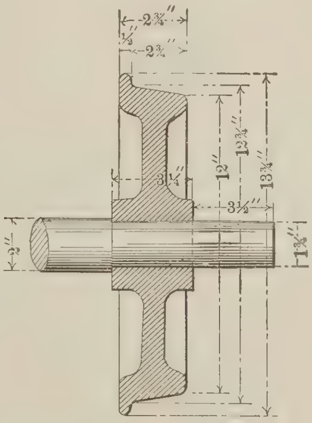


Fig. 12. Plan of Under Side of Tram Car.



Industrial Press, N.Y.

Fig. 13. Section of Car Wheel.

In laying the track, the frogs and crossings of the switches should be first put in place and connected with the straight pieces of track, which may be easily cut to length on the power hack-saw. Such curves as are necessary to connect the switches to the straight track are then put down, care being taken to have the proper pieces of curved track to connect with the straight track so as to properly fit the groove in it. It will be necessary to have a gage by which to locate the second track, after the first line of rails has been put down and correctly lined up.

Another form of track is shown in Fig. 7, for the straight yard track. It has the advantage of having no groove where water, snow or ice may find a lodgment and impair the usefulness of the system. This form of track may also be constructed for the curves, by placing it the proper distance apart to permit the wheels to run up on their largest diameter on the outside rail and their smallest diameter on the inside rail. Grooved track will be needed at the switches.

In fastening down these tracks heavy, flat-head wood screws are used for track having a groove, and lag screws for track constructed as shown in Fig. 7.

In Fig. 8 is shown another form of track for shop floors, letting the rails in flush with the top of the floor. The sides of the track are square with its lower surface, so as to have it fit up to the edges of the floor planks without cutting them to an angle. Curved track is similarly made, the groove being wider but the edges of the track vertical, as shown.

It will be noticed that all this track is of cast iron, as being a cheap and convenient material. Steel rails laid on ties may be used for the straight track if desired, and cast iron rails for the curves and the switches, but the expense will be considerably more, and the additional outlay is not necessary if light loads, say, under two tons, are to be carried.

Fig. 9 shows a plan and cross-section of a turntable. It is composed of two castings; the lower one, or bedplate, being for convenience, made of octagonal form, and having formed in it a proper recess for receiving the turntable proper, which is journaled or pivoted upon a center pin cast upon the bedplate. Two annular bearing surfaces are provided, in addition to the boss around the pivot pin. At the ends of the track-grooves are formed suitable pockets for receiving the ends of the track and holding them in line with the turntable grooves. At one side is shown a simple and convenient latch, *A*, pivoted flush with the top of the bedplate in the projections, *B*. Four recesses are formed in the top of the turntable proper, into any one of which this latch may be dropped as desired. For heavy loads the annular bearing surfaces are sometimes provided with grooves and hardened steel balls introduced to eliminate a large percentage of the friction, but in this case the additional expense is hardly necessary, if the bearing surfaces are kept well slushed with a thick grease. It will be better to face up the bearing surfaces in a large lathe that they may be true and evenly bearing surfaces, but this may be omitted if castings can be had which are straight and true. Where these turntables are used in yards, holes should be left in the bedplate casting to permit the water to run through, and thus avoid as much as possible the danger of their freezing up. The bedplate should be supported by 3 x 5-inch timbers placed directly beneath the tracks in both directions, these being usually used in connection with tracks at right angles to each other.

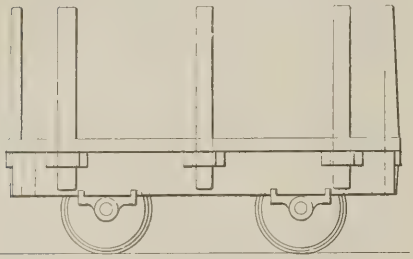


Fig. 14. Car with Removable Stakes.

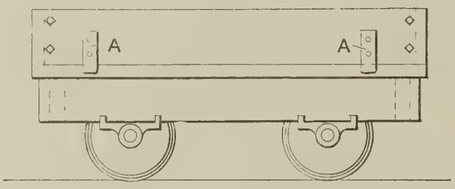


Fig. 15. Car with Removable Box.

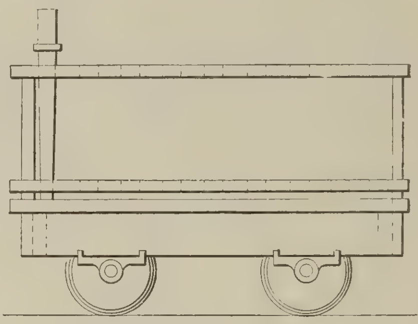


Fig. 16. Car Arranged for Special Work.

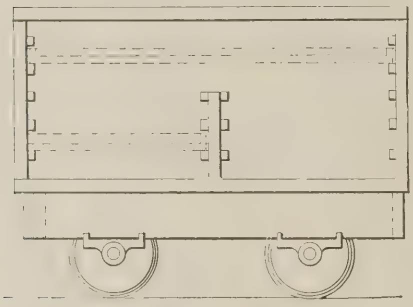


Fig. 17. Car Arranged for Trays.

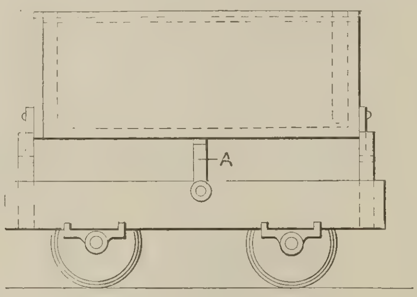


Fig. 18. Side Elevation of Dump Car.

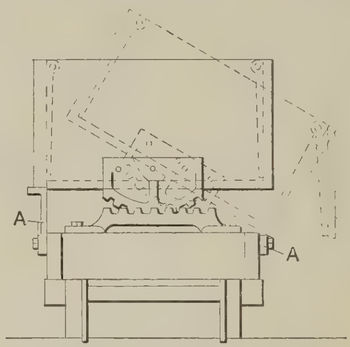
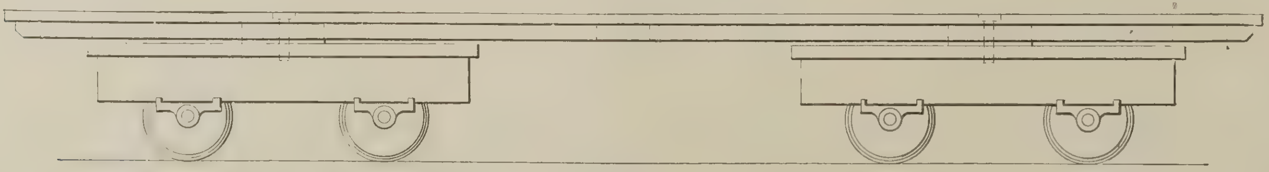


Fig. 19. End Elevation of Dump Car.

It will be noticed that all of this track work is so simple and plain that the work of laying it may be done by any good carpenter; and that the effort is made to have all the arrangements of both track and cars of the most simple and inexpensive character consistent with utility and durability.

A car suitable to run on these tracks is shown in the drawings, in which Fig. 10 shows a side elevation; Fig. 11, an end elevation; Fig. 12, a bottom view; and Fig. 13 a section of one of the wheels, with a portion of the axle. Sufficient dimensions are given to enable any good mechanic to construct them. This car, constructed of oak planks, put together in the manner shown, will be amply strong for loads up to two tons. The top planks are fastened down with ⅝ x 4-inch lag screws, the heads with washers under them, and let in flush with the top of the planks so as to offer no obstructions. The frame is fastened, as will be seen, with ¾ x 6-inch machine bolts, the nuts of which are placed in mortises. The axle boxes are solid and fastened to the car frame by ¾ x 4-inch lag screws, and are also held rigid by ribs let into the side timbers, as shown.



Industrial Press, N.Y.

Fig. 20. Double Car. Two Cars and a Special Platform.

So far we have considered only the plain platform car, which will be used for perhaps a majority of the transportation of material and stock about the plant. But there will be a demand for cars for special work, where a car of special construction and adapted to the conditions will be vastly more convenient, and better suited to the purposes for which it is used. As it has been the aim in designing and arranging this system of shop and yard tracks, and the necessary equipment for them on such a plan, that all the work of construction and installing may be done on the premises, and at moderate expense, the same idea has been carried out in reference to what may be dignified in railroad parlance as the "rolling stock" or equipment for it. With this idea in view, the different styles of cars represented in Figs. 14, 15, 16, 17, 18, 19 and 20, have been designed to meet the requirements of actual practice in the regular routine business of the machine shop and the various departments necessarily connected with it.

The plain platform car, suitable for use in the shops was seen in Figs. 10, 11, 12 and 13. This form is the basis of all the cars shown in the succeeding illustrations. Fig. 14 shows a car with stakes, supported in ordinary cast-iron stake pockets bolted to the frame of the car, proper recesses having been cut in the top planking or platform of the car to accommodate them. These stakes may usually be 20 to 24 inches in height from the top of the car platform, and 2½ x 3 inches at the largest part. Such a car will be useful for transporting lumber in long or short lengths, for forgings, for small boxes, or bundles of manufactured stock to be shipped, as well as many other uses which will readily suggest themselves. In Fig. 15 is shown an ordinary platform car having a box of 1½ to 2-inch plank, held together by ⅝ rods, as shown, and held in place on the car platform by the straps *A A*, so as to be readily removable and adaptable to any of the regular sized cars. This form of car is very useful in transporting lots of small castings, forgings, drop forgings, partially finished work and any kind of stock and material which may be handled roughly and is not too large or clumsy for piling in such a box.

Fig. 16 shows a car specially arranged for transporting spindles, short shafts and similar work which have been finish turned, ground, or have passed through such operations as render their careful handling necessary. In this case a subbase of 1¼-inch plank is placed two or three inches above the car platform, and a similar one at a proper height above it to accommodate the work to be handled. These supporting planks are perforated with holes of a proper size to suit the work. They are supported and held in place by plank ends, corner posts, or in any convenient manner. These supporting shelves or frames may be attached to the car as a part of it, or they may be made removable like the box shown in Fig. 15. This form furnishes a safe and convenient method of handling this class of work.

Fig. 17 shows a car arranged with racks for holding a series of trays for the reception and transportation of small, finished parts, or parts going from the machines to the polishing room, plating room, finished parts storeroom, etc. Such cars may be constructed to take trays the full size of the car platform, one half, or one third of it, or for any combination of these sizes, the trays sliding into their places like the printer's type cases. They will be found very convenient for handling and for accounting for small parts in their transit through the shop.

Figs. 18 and 19 show a dumping car, arranged from one of the regular cars, with the platform omitted. As will be seen, the box or body of the car is not pivoted upon trunnions, but supported upon a cast-iron rack, with cast teeth, at each end of the car, this rack being engaged by a toothed segment fixed to the car body as shown. The object of using this toothed device in preference to simple trunions or pivots, is to carry the car body toward the side where the load is to be deposited when the car is dumped. The device is simple and effective. The side supports, *A A*, are pivoted to the frame of the car and are used to hold the car body in its normal position. The sides of the car body are pivoted at the top, as shown in Fig. 19, and held or released by a simple latch at their lower edge. A small safety chain may be added on each side to prevent the car body from becoming unshipped by careless dumping. These cars may be used in transporting coal, ashes, coke, molding sand, and all similar materials which may be quickly unloaded by dumping. Those used for carrying coal to the boiler room may have a horizontal shelf on a level with the bottom of the car body, and on the side toward the boilers. However, a more convenient arrangement will be a solid box of three sides, or two ends and a side, built upon an ordinary platform car, the side toward the boilers being pivoted at the bottom instead of at the top, as shown. This will be convenient to shovel coal from. But the dumping car, as shown, should be used for the removal of ashes. For either coal or ashes the car bodies should be lined with sheet iron.

Fig. 20 shows a large car formed by placing upon two ordinary flat cars, a platform constructed of 2-inch planks, running lengthwise, and held together by cross bars 2½ inches thick, and a similar bar running lengthwise on each side of the platform, and within two inches of its edge. Such a platform may be from 34 to 42 inches wide, and from 7 to 10 feet in length, according to what use it is intended for. Cross bars, at least 12 inches wide should be built with the platform, at the points over the centers of the cars, and through these is placed a "king bolt" as shown, which furnishes a pivot upon which the separate cars turn, the same as the trucks of a railroad car. It will be readily seen that such a car will carry double the weight of the ordinary platform car as the weight is distributed upon eight wheels instead of four.

Cars for use in the yards may be heavier and longer than those used in the shops if the conditions demand such increase. For instance, the cars may be made 38 inches wide and 6 feet long instead of 34 inches by 5 feet. The frames should then be of 3 x 8 inch instead of 2½ x 7-inch timbers. The wheel base should remain the same, in order to facilitate the passage of the car around the curves.

As to the number of cars necessary for the equipment of the entire plant, much will depend, of course, upon the particular character of the work to be done, but in a general way it may be stated somewhat as follows: Of the ordinary flat cars, as shown in Figs. 10, 11 and 12, there will be needed 16 cars, distributed among the different departments. Of these, six at least should have stake pockets and a sufficient number of stakes provided for them to give ten stakes to a car. There should also be 10 of the removable boxes shown in Fig. 15 for use on them is needed. There should be 6 dump cars for use in the yard, foundry and boiler house. The special cars shown in Figs. 16 and 17, and such modifications of them as may be necessary, will be used mostly in the machine shop galleries, and their number will be determined to a very large extent by the kind of work that is to be done. There should be at least two of the platforms shown in Fig. 20, to be used on any of the flat cars. The number of cars above mentioned are considered really essential to the proper handling of the usual classes of stock and material, but a larger equipment will doubtless be advisable whenever the first cost is not closely limited.

* * *

NOTWITHSTANDING GREAT ODDS.

Editor MACHINERY:

There fell from the ranks on February 2 a man who, though but a humble workman, was yet in some ways so remarkable as to be worthy of notice as an example of true grit and manly independence.

Orlando M. Grimes.

Orlando M. Grimes, a Vermonter by birth, was, while serving his time as a machinist apprentice in 1863, caught in the shafting and before it could be stopped had both of his legs and his left arm broken, and so serious were his injuries that upon recovery, which did not take place for nearly a year and a half after the accident, he could not take a step longer than 12 inches nor raise either foot higher than 6 inches; and to walk a hundred yards required so much effort as to throw him into a perspiration even on a cold winter day. The small bone of his left arm was removed and his left hand and arm thereby rendered almost useless. Under these discouraging conditions he finished his apprenticeship and started out as a journeyman, and he succeeded so well that he could always command the pay of a first-class workman, both by reason of the quantity and the quality of his work.

All the later years of his life he worked in the tool-making branch of the business and among the highest grades of the work. He was naturally more efficient in machine work than in bench work, yet at the bench he could do as much and better work than the average workman.

It was instructive to any one to watch him maneuver to perform the different operations upon a piece of work and to see how he made every move count. He never asked for help in any work that was usually done by one man, though it was often offered to him.

He was of a deeply religious nature and regularly gave one-tenth of his earnings to charitable and religious organizations.

It is greatly to the credit of human nature that in making application for work he was only upon a few occasions spurned from a shop door by reason of his physical condition.

He has worked in a large number of the shops of the Eastern and Western States, and it is probable that many of MACHINERY'S readers will remember him. He is survived by his widow, who lives in Arlington, N. J.

Brooklyn, N. Y. J. R. GORDON.

LETTERS UPON PRACTICAL SUBJECTS.

TO OUR CONTRIBUTORS.

We wish to call the attention of some of our valued contributors to what is considered a serious breach of faith in the publishing business, and that is, sending substantially the same contributions to two or more publications with the expectation of receiving payment. Any contribution to a reputable journal should be regarded as its own unless rejected and returned. Practically all contributions to this department are paid for upon publication, which, of course, makes them the property of The Industrial Press. Sending the same contribution to another journal is substantially the same as selling one article to two buyers. Moreover, it puts the journal appearing last in a bad light—that is, of apparently appropriating matter from another journal without credit.—Editor.

RE BEVEL GEAR FORMULAS.

Editor Machinery:

In reviewing the November, 1903, number of Machinery, I once more read the article "Bevel Gear Formulas," by J. D. Adams. I would like to ask Mr. Adams through your columns why he wrote formulas 3, 4 and 5 as he did. I would prefer to write them as below, since they would then be less confusing to the beginner.

$$\phi = \tan^{-1}\frac{D_1}{D} \qquad (3) \qquad \tan\phi = \frac{D_1}{D}$$

$$O = \tan^{-1}\frac{2}{P\sqrt{D^2 + D_1^2}} \qquad (4) \qquad \tan O = \frac{2}{P\sqrt{D^2 + D_1^2}}$$

$$I = \tan^{-1}\frac{2.314}{P\sqrt{D^2 + D_1^2}} \qquad (5) \qquad \tan I = \frac{2.314}{P\sqrt{D^2 + D_1^2}}$$

However, I, for one, wish to thank Mr. Adams for his article. Chas. E. Miller.

Akron, Ohio.

RE THE DIE THAT CRACKED IN HARDENING.

Editor Machinery:

A few words regarding the die as described by "D. M. M." in the "How and Why" column: I agree fully with Mr. E. R. Markham's explanation; and I also think that D. M. M. can consider himself extremely fortunate that only one crack appeared, as a die containing over 200 holes is a very difficult piece to harden. Even if luck should favor D. M. M. in hardening his next die without *cracking*, I think it is safe to state that it is impossible to harden a die containing over 200 holes and have the holes remain in the same *relative position* as before hardening.

The writer suggests to D. M. M. that a very satisfactory die, accurately spaced when ready for use, can be made by using a block of machinery steel, recessed to allow the insertion of small tool steel bushings. By making the die in this manner a broken die can be easily repaired simply by forcing out the broken bushing and inserting a new one. On the other hand, if a die is solid and one of the dies breaks, the whole die (200 holes) has to be annealed, greatly increasing the chances of cracking when re-hardening, to say nothing of the holes changing their positions, which necessitates bending the punches in order to align same with die, etc. Then, too, the piece punched is not the same as those previously punched.

All things considered, a die containing a number of holes, especially a die with over 200 holes, should never be made solid. Frank E. Shailor.

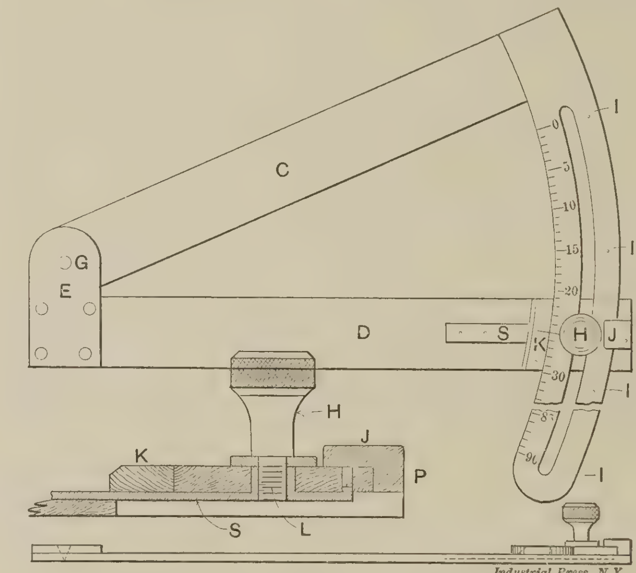
Great Barrington, Mass.

A COMBINATION TRIANGLE AND PROTRACTOR

Editor Machinery:

The accompanying sketch shows a plan and section of a combination triangle and protractor that the writer has found to form a very useful drafting instrument. The two blades, *C* and *D*, lie flat on the board and are connected at their inner ends by the plate, *E*, and at their outer ends by the quadrant, both of which lie on the top of the blades. The plate *E* is riveted to the inner end of the lower blade and hinged to the upper one, there being a small hole through the rivet, *G*, in order to locate a point on the drawing board, or for passing a pin through into the board, when the pin can be used as a pivot. This hole is countersunk from the upper side to facilitate locating it over a given point.

The quadrant is riveted to the upper blades and slides freely on the lower one and is clamped firmly by the knurled head screw, *H*, or kept in place by the spring, *S*, with its pin, *P*, coming up into one of the holes, *I I I I*, which are shown at 0, 15, 30, etc., degrees, but may be placed at whatever angle the protractor is most frequently used. The small plate *K* fits the graduated edge of the quadrant and comes even with its top surface, making it easy to adjust the graduations with the line on the plate *K* very accurately. The spring *S* fits into a recess in the blade *D*, and is riveted firmly to the same on its plain end. The lug for *L* projects into the long slot in the quadrant and presses against the washer. By screwing down the knurled head screw *H* the quadrant is clamped firmly to the blade, *D*, and by loosening this screw slightly the quadrant slides freely back and forth. By backing the screw a little further out the pin, *P*, on the spring, *S*, presses against the under side of the quadrant and springs into the first one of the holes *I I* that comes above it. The quadrant is prevented from being raised from the blade by the small plate, *J*, which overhangs its outer edge. The quadrant being on top of the other blades is high enough to pass over the top of the T-square, making it a practical tool to use in any place where ordinary triangles are used.



Industrial Press, N. Y.

Combination Triangle and Protractor.

Watervliet, N. Y. M. H. Ball.

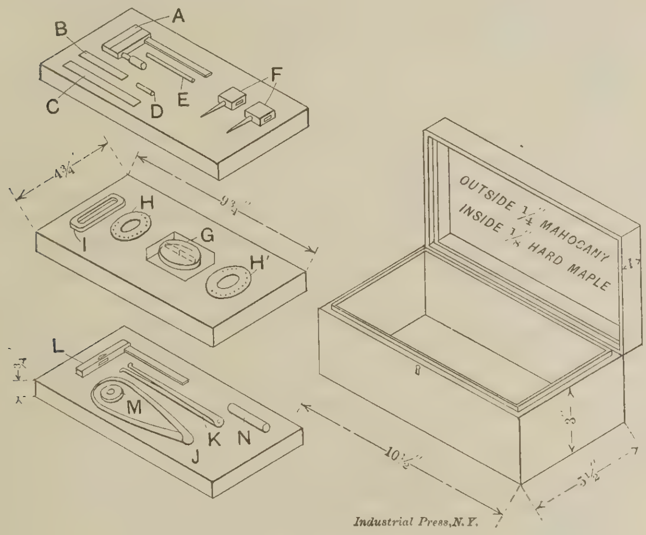
UNIQUE DRAFTING SET.

Editor Machinery:

Some little time ago I saw how a man could carry the instruments that he might need for almost any business or service in a very small and handy box, and I feel sure it will interest some readers of Machinery.

It is a somewhat common but nevertheless erroneous impression that the young man who goes into the office to make drawings will have nothing to do but trace or make pencil sketches. This may be true in some cases, possibly in large works, where, of course, a great many of the young men do not find very much opportunity to get around the works, but in the smaller plants it is different. There even the last comer is often called upon to go out and measure up something that has been brought to a state approximating perfection, or perhaps to measure up something that is so very far from the state of perfection that it has broken down. In such cases a man may need a great many things not contained in the sets of drawing instruments listed in the catalogues of the dealers. The particular set that I wish to describe consisted, exteriorly, of a neat little wooden box having a spring lock and key. The owner commonly kept immediately inside on the top a nice leather pocket case of ordinary drawing instruments and under the space provided for this pocket case there was space for three small trays. Each tray was made of a piece of well-seasoned wood, covered on the under side with a piece of thick plush or velvet. The upper side of the piece was carved or recessed amply large for the instrument to be carried there, and over these recesses and all was secured another piece of velvet. The edges and ends of each piece of wood alone were left bare, but the edges and ends of each of these pieces, as well as the inside of the box, were neatly finished in hard varnish. As a ready means of lifting each tray there was secured from end to end a piece of heavy black braid about ½ inch wide. In the trays, of course, were the various instruments that are so commonly needed and often so hard to find, and all these trays, being of the same size, anyone could be put above the others for ready use.

We will now describe them in order as they were commonly kept. The upper one carried a 6-inch beam micrometer, *A*; a 4-inch and 6-inch scales, *B* and *C*; 1-inch and 4-inch standard test piece, *D* and *E*; and a pair of beam compass points, *F*. The next tray was fitted with a pocket compass having a bar needle and inclinometer secured to a square brass-plate having one edge turned up (as we often see used by geologists) *G*, and on each side of this were two circular wire gages of different makes, *H H′*, and at the end was a coil of fine magnet wire, *I*, that could be used with the compass to make it a temporary galvanometer. In the lower tray were a pair of ordinary calipers (inside and outside), *J* and *K*; a small steel square with a level, *L*; and a 25-foot steel pocket tape, *M*, divided to feet, inches and 16ths on one side and metric measurements on the other side. On the side of this tray there was also a strip of brass about No. 24 gage, divided on each side into 100 equal parts and pivoted in the center so that it might be used as a scale beam. In a suitable recess was a tin case, *N*, containing a set of metric weights, which, together with the graduated brass strip made it easy to obtain small weights quite accurately and quickly.



Unique Drafting Set.

Burlington, Iowa. F. W. Salmon.

THE VALUE OF THE COOPER-HEWITT LAMP FOR PHOTOGRAPHIC AND OTHER USES IN THE SHOP.

Editor Machinery:

Anyone who has had much to do with photographing machines knows how often the conditions are adverse to good work. The machine is usually located in a part of the works where the light is very poor, and if the machine is of such a size that moving it to a better lighted part of the works is practically an impossibility it always taxes one's ingenuity to "light the object," as it is termed. As the varying qualities of light and shade are what makes the picture, it is under any circumstances a matter calling for much skill to so graduate the light at one's service as to get results that are satisfactory.

Firms that find it necessary to photograph most of their machines make a provision for such work by providing suitable skylights, screens, etc. The use of artificial lighting methods has been tried, but seldom with much success. I would therefore like to call attention to some photographs made by the light of the so-called Cooper-Hewitt lamp. One lamp only was used in this work, and the work was performed in a large hall with walls painted such a color as would least help reflect actinic light. The conditions, it will thus be noted, were adverse to good lighting and show what might occur if the lamp was used in an ordinary shop room.

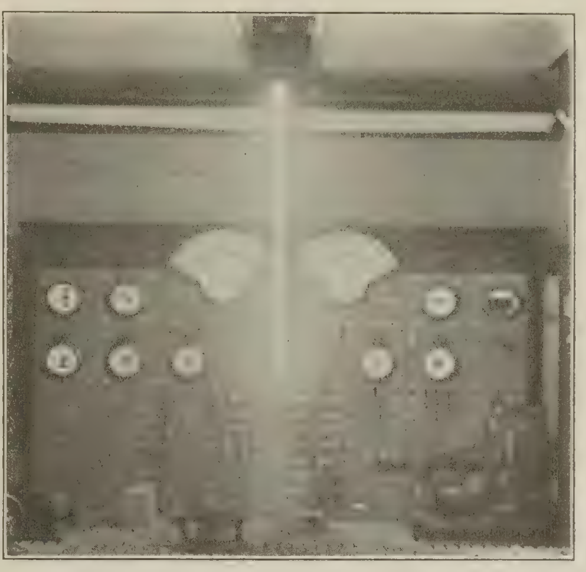


Fig. 1. The Cooper-Hewitt Lamp.

The photograph from which the half-tone, Fig. 1, was made, shows the relative position of the lamp and the machine to be photographed; Fig. 2 shows the result when used to furnish light for photographing the machine; and Fig. 3 demonstrates that with only one lamp a large hall may be so evenly lighted as to show up in the negative with fair results.

This light has already been adopted in some of the portrait studios with excellent results, and usually three lamps mounted in a grid or frame are so used. The light is not only soft and mellow to the vision, but soft mellow effects in lighting the subject can be obtained. Using the light for photographic purposes, one is struck by its uniform distribution as compared with other artificial lighting. Fig. 3 shows this, by the furthest corners being nearly as well lighted as those nearer the lamp. Reading also is possible at distances from the lamp that seem wonderful when other lighting is considered.

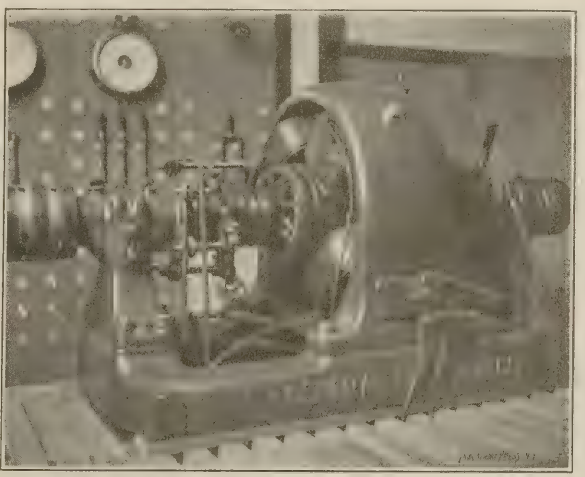


Fig. 2. From Photograph taken by the Cooper-Hewitt Light.

The lens used in making these photographic exposures was stopped down to F 16 and the length of exposure was ten seconds in all three exposures. The plates were Seeds, N. H., and were treated in development as if exposed by sunlight. All exposures were made several hours after dark and with no other lights burning.

It would seem as if this lamp might be of great use to those who find it necessary to photograph objects in places where the light is uncertain, or perhaps a minus quantity altogether.

For the benefit of those who have not seen this lamp a brief description of it may not be amiss. The lamp as shown in Figs. 1 and 4 is a glass tube of less than two inches diameter and about four feet in length, with a bulb blown upon one end. Wires are fused into the ends of this tube when it is closed, and enough mercury is introduced to form a small puddle at its lower end. The air is exhausted from the tube until a very perfect vacuum is formed. The lamp thus presents the appearance of a long glass tube closed at the lower end and with an incandescent bulb blown upon its upper end, closing that also. In use, one or more of these lamps are held in a light frame by simple clamps embracing the tube near its ends. This frame is hung in such a manner as to permit of swinging the lamp up beyond the horizontal for starting. To start the lamp it is swung up until the puddle of mercury is in the upper bulb, the current is applied and the lamp is swung down in such a manner as to form a thin stream of mercury the entire length of the tube, forming a path for the passage of the current between the ends of the tube. As the stream of mercury breaks, vapor of mercury is formed, and the current continues to pass through this vapor, rendering it highly luminous, and giving off a very powerful light. As it takes a very high potential to break down or disintegrate the mercury, certain coils and apparatus are needed in starting, but when once started, the lamp runs with an exceedingly small power.

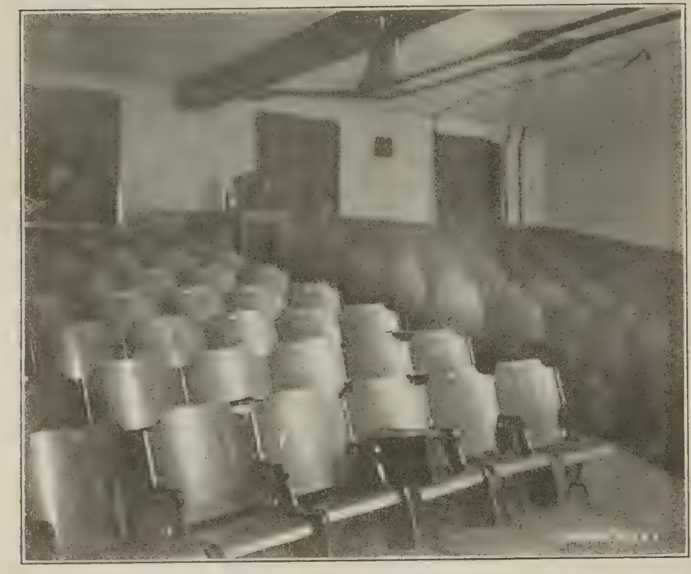


Fig. 3. From Photograph of Lecture Hall taken by Cooper-Hewitt Light.

Fig. 4 represents a vertical section of the lamp and shows something of the design. *A* is the glass tube and, as will be noticed, it projects into the condensing bulb that closes the upper end. This allows a puddle of mercury to remain there and the upper puddle *B* is the positive electrode, while the puddle at the lower end, *C*, is the negative electrode.

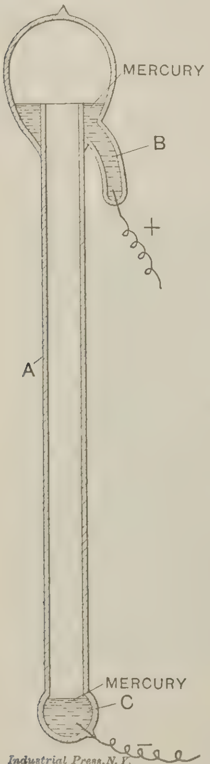


Fig. 4. Vertical Section of Cooper-Hewitt Lamp.

As the mercury vapor condenses in the upper bulb it trickles over the end of the tube, falling to the lower puddle, and is again vaporized. When working properly the tube is comparatively cool and the lamp gives off little heat.

A seven hundred or eight hundred candle power lamp uses no more power than that sufficient to run say three thirty-two candle power incandescent lamps. The vapor of mercury being in a vacuum, no waste is possible, there is no noise, and no flickering, and when the lamp is once started it requires no further attention. The light produced comprises orange-yellow, lemon-yellow, green, blue, blue-violet and violet, but no red rays. This absence of the red rays makes it a very noticeable light and produces ghastly effects upon the human countenance when viewed by it. One, however, ceases to notice this effect after a short time, and the absence of the red makes it an exceedingly restful and desirable light for drafting rooms and fine mechanical pursuits. The light is very rich in actinic rays and it is the property that makes it peculiarly valuable for photographic purposes.

Worcester, Mass. H. P. FAIRFIELD.

A "QUINTUPLE" COMBINATION DIE FOR PRODUCING FIVE DRAWN AND EMBOSSED TIN SHELLS IN ONE OPERATION.

Editor MACHINERY:

The development of the art of sheet metal-working and the improvements made in the tools used have been so rapid during the last few years that only those who are directly engaged along these lines have been able to keep pace with the construction of the tools used in such work. Thus, we find that tools which yesterday were thought to represent the height of perfection, in regard to longevity and production, are to-day obsolete because of others having been designed and put in successful operation for accomplishing many times the work of the former.

Of all the different processes of sheet metal working, however, it is in the drawing and forming of decorated tin boxes that we find the greatest innovations being introduced in the tools for their production; and it is my purpose in this article to illustrate and describe a set of tools used for the production of decorated tin shells, which should prove interesting to many sheet-metal goods manufacturers and to all diemakers.

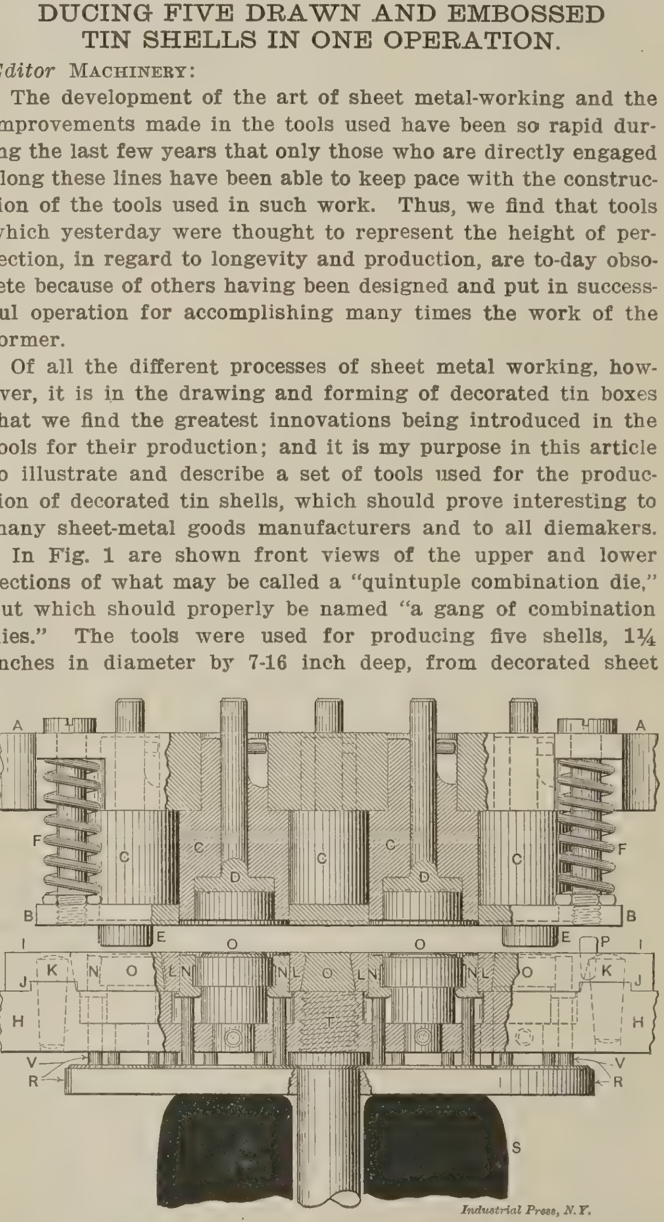
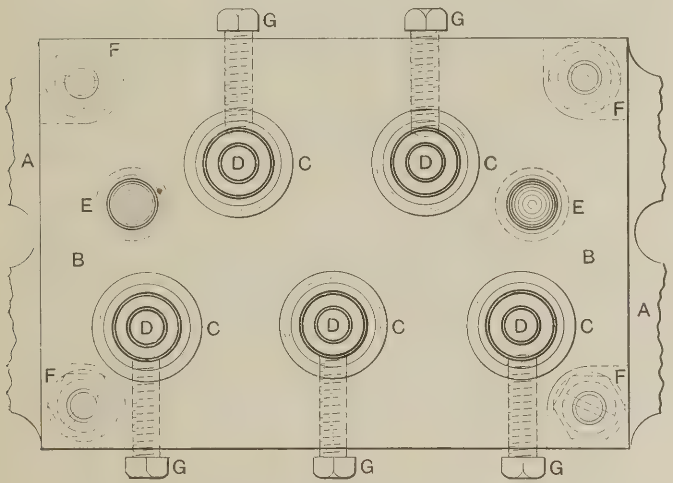


Fig. 1. Front View of Quintuple Combination Die showing Assembled Construction.

In Fig. 1 are shown front views of the upper and lower sections of what may be called a "quintuple combination die," but which should properly be named "a gang of combination dies." The tools were used for producing five shells, 1¼ inches in diameter by 7-16 inch deep, from decorated sheet tin in one operation, the work done including blanking, drawing and embossing. The principle of construction carried out in the tools is essentially the same as that found in the usual single-action combination drawing die, and no attempt will be made here to give a detailed description of the making of the various parts, as the proper practice is now well known to all who are interested in such work. A general description of the assembling of the parts and the work accomplished will suffice for all purposes and, in conjunction with the engravings, point out to the practical man how similar tools may be adopted for the production of work of the same nature in like or even greater quantities. I can see no reason why the principle may not be further extended in tools to produce a greater number of shells than those shown here, if a press of suitable dimensions and of sufficient strength can be procured.

As stated before, Fig. 1 is a front view showing, in conjunction with other things, sectional views of the first row of punches and dies, so that their construction may be clearly understood. Fig. 2 is a plan of the punch, or upper section of the tools; Fig. 3, a plan of the die section; Fig. 4, details of the smaller or working parts of the punch section; and Fig. 5, details of the smaller or working parts of the die section; while Fig. 6 illustrates the manner in which the stock is fed and punched so as to secure the maximum number of shells from a sheet and the minimum of scrap or waste.

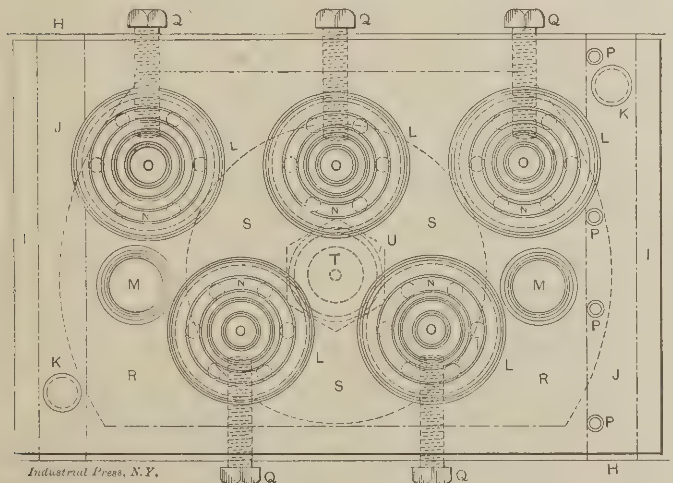


Industrial Press, N.Y.

Fig. 2. Plan of Punch Section.

By taking Fig. 1 as the main reference drawings and referring occasionally to Figs. 2 and 3, the construction of the tools will be more easily understood. The positions of the details in the finished tools, Figs. 1, 2 and 3, may be determined by comparing the reference letters, which are identical in all drawings.

The lower or die section consists of, first, the main die plate *H H*, in which are located the five drawing and embossing punches *O, O, O, O, O*, the five blank holder rings *N, N, N, N, N*, the thirty spring barrel tension pins (six to each die), the spring barrel stud *T*, and five setscrews *Q, Q, Q, Q, Q*, for fastening the drawing and embossing punches.

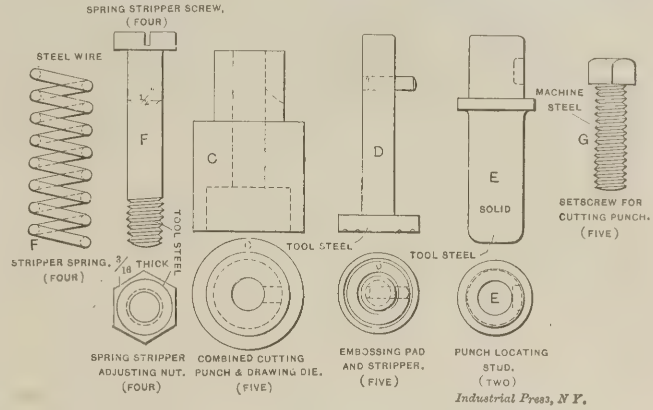


Industrial Press, N.Y.

Fig. 3. Plan of Die Section.

Then we have the upper die plate *I I*, in which are contained the five cutting dies *L, L, L, L, L*, the two punch locating stud bushings *M M*, and the four stock gage pins *P, P, P, P*. The two die plates are of machine steel, and are located in alignment with each other by the two taper hardened dowels *K K*, and fastened by bolts at the ends, which are not shown. *R* is the upper spring buffer plate of cast iron, and *S* the rubber buffer. The machining and finishing of the seats for the various dies in the die plates necessitated some very accurate and careful work in order to assure alignment of the working parts.

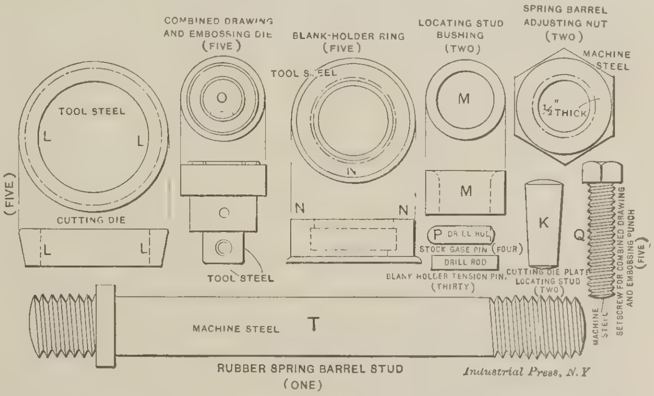
In the upper or punch section, Fig. 1, we have, first, the holder, in which are contained the five combined cutting punches and drawing dies *C, C, C, C, C*, with their combined strippers and embossing pads *D, D, D, D, D*, the spring stripper *B B* for the stock, and the two punch locating studs *E E*, while *G, G, G, G, G*, Fig. 2, indicate the setscrews for fastening the punches within the holder. The holder is cast iron, while the stripper plate *B B* is machine steel. The combined cutting punches and drawing dies are of tool steel and were hardened, drawn and carefully lapped and ground, as were also the five combined strippers and embossing pads, *C, C*, etc. The locating studs were also accurately made.


SPRING STRIPPER SCREW, (FOUR)
STEEL WIRE
F
F
C
D
E
SOLID
MACHINE STEEL
G
SETSCREW FOR CUTTING PUNCH. (FIVE)
TOOL STEEL
TOOL STEEL
TOOL STEEL
STRIPPER SPRING. 3/16 THICK (FOUR)
E
SPRING STRIPPER ADJUSTING NUT. (FOUR)
COMBINED CUTTING PUNCH & DRAWING DIE. (FIVE)
EMBOSSING PAD AND STRIPPER. (FIVE)
PUNCH LOCATING STUD. (TWO)

Industrial Press, N Y.

Fig. 4. Details of Small Parts of Punch.

It will be noticed that the two die plates *H H* and *I I* have their perfect alignment further assured by locating them by the tongues and grooves. The five cutting dies were forced into taper holes in the plate *J J*, while the five blank holder rings *N, N, N, N, N* were made so as to press up against the shoulders of the drawing punches *O, O*, etc., thus eliminating their tendency to work the cutting dies loose. The thirty spring buffer tension pins were of drill rod, and were accurately finished to size in length, being finished to within a limit of variation of one thousandth inch. Insignificant as they appear, these tension pins play a most important part in the proper working of a die of this kind, whether single or multiple in action. Unless they are finished accurately, so as to be of the same length, there is no possibility of drawing the metal uniformly, free from wrinkles, or without marring the decorations, through the unequal pressure which will be communicated to the blank holder rings by the inaccurately made tension pins. The manner in which the tools are used and the shells produced will be understood from the following:


COMBINED DRAWING AND EMBOSSING DIE (FIVE)
BLANK-HOLDER RING (FIVE)
LOCATING STUD BUSHING (TWO)
SPRING BARREL ADJUSTING NUT (TWO)
MACHINE STEEL
TOOL STEEL
TOOL STEEL
L
L
O
M
1/2" THICK
(FIVE)
N
CUTTING DIE
O
N
N
M
K
Q
L
L
P DRILL ROD
STOCK GAGE PIN (FOUR)
DRILL ROD
TOOL STEEL
BLANK HOLDER TENSION PIN. (THIRTY)
CUTTING DIE PLATE LOCATING STUD (TWO)
SETSCREW FOR COMBINED DRAWING AND EMBOSSING PUNCH (FIVE)
MACHINE STEEL
MACHINE STEEL
T
RUBBER SPRING BARREL STUD (ONE)

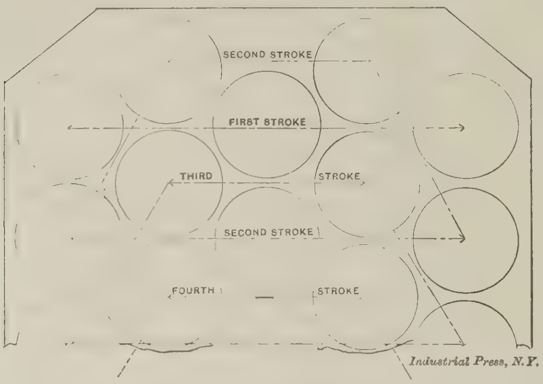
Industrial Press, N.Y

Fig 5. Details of Small Parts of Die.

Both sections are set up in an inclinable power press which is furnished with a two-bar knockout in the slide, so as to actuate the stripping and embossing pads *D, D*, etc., in the punches. The punch section is fastened to the press ram by bolts, and the die section to the press bolster by large cap screws. I might state that the press in which the tools were used is very powerfully geared and weighs about 3,500 pounds. It has a standard stroke of 2 inches, a maximum stroke of

3½ inches, and a circular opening in the bolster 13 inches in diameter. Both sections of the die were located in alignment by lowering the press slide and entering the two locating studs *E E* into the bushings *M M*. Then the stroke was adjusted, the spring buffer pressure regulated, and the work was ready to proceed.

The press being inclined, the metal is fed from right to left, one edge resting against the gage pins *P, P, P, P*, and the end extending to the edge of the back row of (three) dies. The press, being stepped, the punch section descends and the stock stripper *B B* flattens and holds the stock securely on the face of *J J* while the blanks are being cut into the cutting dies *N, N*, etc., and drawn up into the cutting punch and embossed. As the slide rises the stripper *B B* sheds the stock from the punches, and the double bar knockout in the press slide actuates the five stripping and embossing pads *D, D*, etc., causing them to descend and strip the finished shells from the punches, when they drop to the die face and fall off at the back by gravity.



Industrial Press, N.Y.

Fig. 6. Showing how the Stock is Fed and Punched to secure Minimum of Scrap or Waste.

When it is realized that the product of the tools shown here was equal to five times the work of a single combination die, their output in a day of ten hours can be imagined, and the saving in labor and expense appreciated. Is it any wonder, then, that, not counting the cost of material, circular decorated and embossed shells of the dimensions here given can be furnished the consumer at the rate of 2 cents per 100, and in some instances, when the quantity ordered is well up in the millions, at even a lower rate?

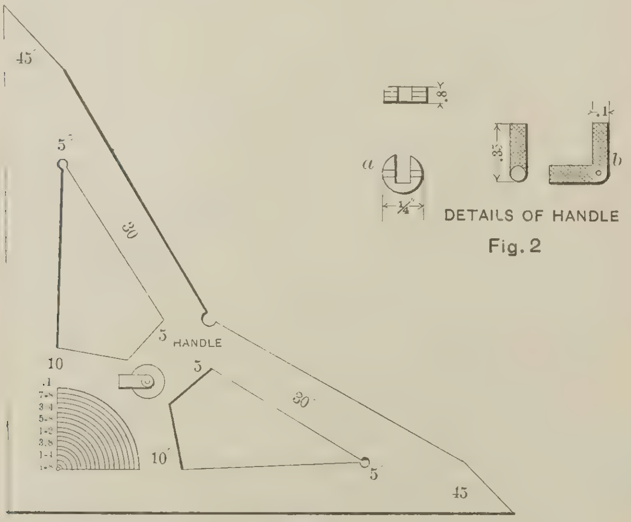


Fig. 2

Fig. 1

CONVENIENT TRIANGLES FOR DRAFTSMEN.

Editor MACHINERY:

We of this generation and of the drafting profession are accustomed to think of ourselves as being particularly open-minded and hospitable to new ideas, but the coaxing sometimes required to get us to adopt new and almost obviously good things, does not always confirm this flattering view of ourselves. Many of your readers will, no doubt, recognize the triangles shown in Figs. 1 and 3 as being time-savers, but the idea is not new. However, I have never seen them described in print, although I have been using them for a number of years. On many details no previous laying off and penciling is required; the inking can be done rapidly and at once.

The 6-inch triangle shown in Fig. 1 is made of celluloid, thereby giving it the advantage of transparency. In the left-hand corner a hole is drilled with a No. 60 drill, and 90-degree arcs are drawn with it as a center, at distances 1-16 inch apart up to 1 inch radius. When a center is to be located at a certain radius, say, for a fillet joining two lines at right angles, place the triangle so that the ends of the arc of the required radius coincide with the lines and then with transfer-plug locate the center.

The triangle has a combination cut in it which will be found very handy in hurry-up jobs and drawing details such as wood screws, section lines, right- and left-hand screws, threads, etc. In the center is placed a small reversible handle, which is shown in detail in Fig. 2. It is made of German silver and the part *a* is driven into a hole bored in the celluloid. The notch in *a* is extended into the celluloid so as to afford space for one handle to lie in the plane of the protractor while the other projects upward. The triangle can be picked up from either side with this handle without the bother of unscrewing and screwing in, as we are accustomed to with the ordinary form.

The triangle shown in Fig. 3 is made of sheet steel, and is nickel-plated. A space is cut out on both sides and 3-inch scales are laid off on the beveled inner edges. The beveling is on side only, of course. One scale is laid off in 1-16 inch divisions and the other in 1-50 inch divisions. In the lower left-hand corner a space is cut out giving a scale exactly 1 inch long. This will be found most convenient for laying off center lines, sizes and heads for some kinds of screws, etc. The other angles come in very handy for every day use.

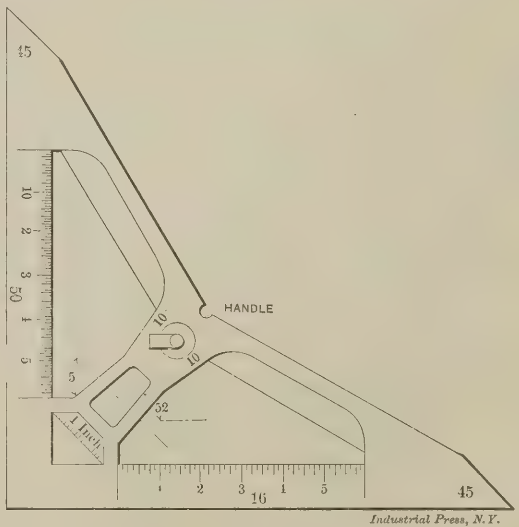
New Haven, Conn. A. L. MONRAD.

THE DETERMINATION OF RISES, CHORDS, AND RADII OF CIRCULAR ARCS FROM THE CO-ORDINATES OF A CURVE.

Editor MACHINERY:

It frequently happens that a draftsman or a mechanic has to determine or lay out the radius of a circular arc when the rise and chord are given. Templets in structural work, window and door centers, and circular crowns on pulleys are familiar examples.

Substituting in an equation involving the square of the chord and the sum of two fractions, or consuming valuable time in making a geometrical construction to a reduced scale is the usual procedure.



Industrial Press, N.Y.

Fig. 3.

The object of the diagram shown is to lessen the labor which is usually experienced in finding the radius of a crown when the rise and chord or base are given. The use of the curve is illustrated by the following example: Determine the radius of an arch whose rise and base are 7½ inches and 100 inches respectively. 7.5 ÷ 100 = .075, which is the rise for one inch width of chord; following the horizontal line passing through .075, we note that the reading at the foot of the vertical line passing through the intersection of the horizontal line and the curve is 1.70; then 1.70 × 100 = 170, which is the desired radius. If other ordinates are desired besides the given rise they are as easily found from the curve by taking convenient and shorter lengths of chords with the same radius and subtracting from the given rise.

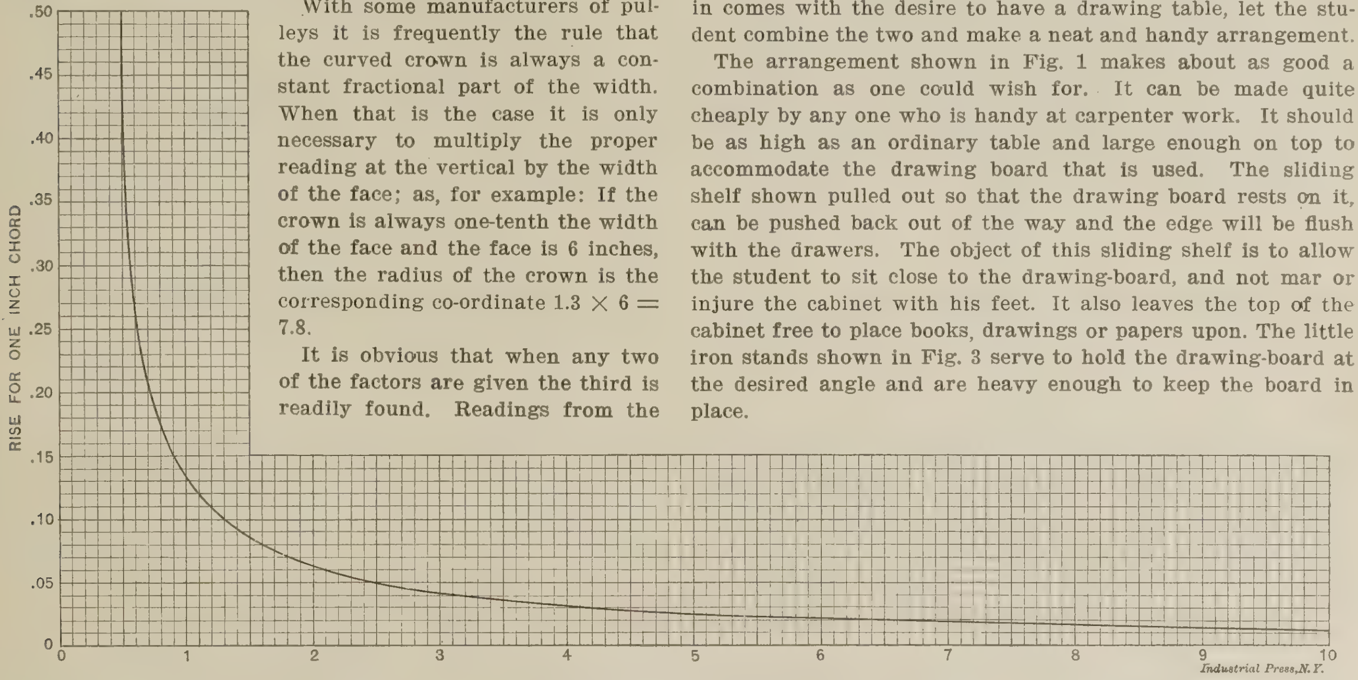


Diagram for Graphical Determination of Rises, Chords, and Radii of Circular Arcs from Co-ordinates of a Curve.

With some manufacturers of pulleys it is frequently the rule that the curved crown is always a constant fractional part of the width. When that is the case it is only necessary to multiply the proper reading at the vertical by the width of the face; as, for example: If the crown is always one-tenth the width of the face and the face is 6 inches, then the radius of the crown is the corresponding co-ordinate 1.3 × 6 = 7.8.

It is obvious that when any two of the factors are given the third is readily found. Readings from the curve are easily taken within one-half of one per cent. of accuracy. Absolute accuracy, which is rare and usually impracticable, can only be obtained by substitution and computation in a long formula.

Ithaca, N. Y. C. E. Coolidge.

A HANDY DRAWING CABINET FOR HOME USE.

Editor Machinery:

Drawing or drafting during spare evenings at home, has become quite a common occupation for young men of ambition whose minds are turned in a mechanical direction. The usual outfit to start with, is a drawing-board, T-square and triangles, with a cheap set of drawing instruments, using the kitchen table as a base of operations. Every time the student wishes to do some drawing he is obliged to go to a closet or pantry, take out his "kit" and distribute it over the table before he can begin work, and it usually happens that he will be obliged to hunt up two or three articles he has forgotten before he is finally ready for work. Then when he is through he is obliged to pack up his kit in as small a space as possible and put the instruments back where they are kept. After a while this sort of proceeding becomes monotonous and the student desires something handier, so he starts in to devise some style of drawing table. By the time the student feels the need of a drawing table he has quite a collection of drawings on hand that need a place where they can be kept handy and in good condition. Now as the need of a cabinet to keep his drawings in comes with the desire to have a drawing table, let the student combine the two and make a neat and handy arrangement.

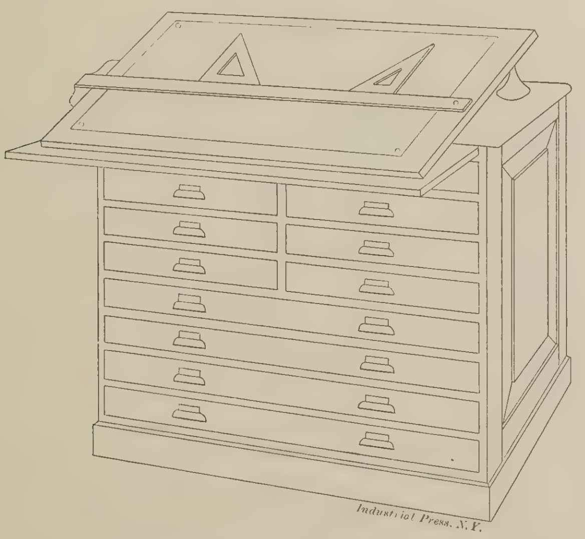


Fig. 1. Drawing Cabinet for Home Use.

The arrangement shown in Fig. 1 makes about as good a combination as one could wish for. It can be made quite cheaply by any one who is handy at carpenter work. It should be as high as an ordinary table and large enough on top to accommodate the drawing board that is used. The sliding shelf shown pulled out so that the drawing board rests on it, can be pushed back out of the way and the edge will be flush with the drawers. The object of this sliding shelf is to allow the student to sit close to the drawing-board, and not mar or injure the cabinet with his feet. It also leaves the top of the cabinet free to place books, drawings or papers upon. The little iron stands shown in Fig. 3 serve to hold the drawing-board at the desired angle and are heavy enough to keep the board in place.

The two upper drawers can be used for drawing instruments, pencils, and any miscellaneous articles that may be desired for use. By placing the drawer that holds the ink and instruments on a chair by the side of the student they will be handy for use.

It is convenient to have two sizes of drawers and two sizes are shown in Fig. 1. One of the small drawers is shown in Fig. 2. All of them will be better if not made too deep. The best depth is about 2½ inches. A board about 12 inches wide and 3-16 inch thick placed on the top and back of the drawer will aid in keeping the drawings flat and in good condition. The drawers can be numbered by placing a properly marked index card in the slot shown above the handle of each, and the drawings can be so arranged that each one can be found readily and without injury to the others.

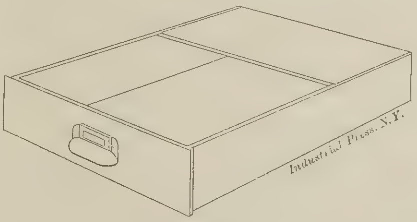


Fig. 2.

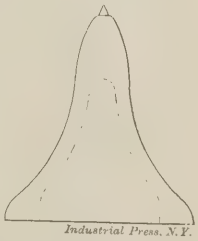


Fig. 3.

With a cabinet of this construction it will take a moment for the student to take out the drawer containing the instruments, pull out the sliding shelf, place the drawing-board upon it and he is ready for work. When he has finished work it will take but a moment to place the different articles in readiness for the next evening's work, and he always knows that anything he needs in his work is at hand. F. W. A.

* * *

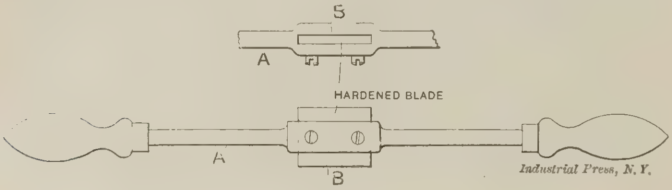
An English firm, Drake & Gorham, Westminster, London, are exploiting a magnetic clutch designed to supersede countershafts in shops. The cone pulley is mounted directly on the lineshaft and is made to rotate with it when the machine is running by means of the magnetic clutch which, of course, is energized by an electric current, under control of the operator. It is claimed that noise is reduced, that a large saving in power is effected by its use and that shop lighting is much better because of the absence of countershafts.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

HANDY SCRAPER FOR BOXES.

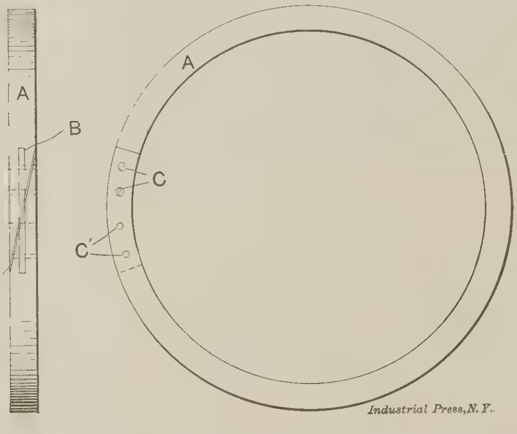
The sketch shows a scraper having two handles, which was recently seen in use in the shop of Schumacher & Boye, Cincinnati, O., scraping out lathe headstock boxes. The tool consists of a forging, *A*, having handles fixed on the ends, and a slot put through the enlarged center part. In this slot is fixed the cutter blade, *B*, held in place by two screws. The advantage of this construction over that of the single-handle side-cutting scraper, is that the tool can be grasped with both hands, thus making the work easier where it is possible to attack it in the way it is done on lathe headstocks, that is, with a hand on each side of the box. The blade is a comparatively small piece of steel which makes it feasible to have quite a number of blades for the same stock, if desired.



Industrial Press, N. Y.

METHOD OF MAKING RINGS FOR SELF-OILING BEARINGS.

An electrical manufacturing concern has an interesting method of making rings for self-oiling bearings, especially those for large generators. The ring *A* is made of brass or bronze, cast in one piece without joint. After it has been bored, faced and turned, a slot *B* is milled or sawed lengthwise through the ring. In this slot a piece is closely fitted to fill the space. Then four holes, *C C* and *C′ C′*, are drilled and tapped for screws. Two of the screws are put through from one side, and the other two from the opposite side. The piece *B* is then removed and a diagonal cut *D* is made, dividing the ring so that it can be sprung over the shaft. Then the tongue piece *B* and the screws are assembled. The advantage of this method is that the shape of the ring when assembled is not distorted, it being left exactly the same diameter all around.



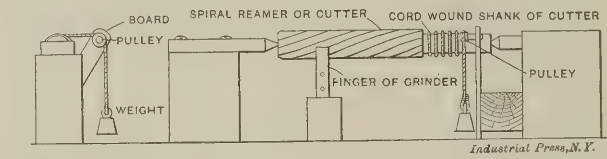
Industrial Press, N. Y.

DRILLING HARDENED STEEL PLATES.

It is a common thing to draw the temper of a tool or other piece of steel on the emery wheel, but this has usually a detrimental effect and one that has to be guarded against rather than to be sought after. "F. J. K.," however, sends us an account of how he was able to overcome considerable trouble by this principle. Having ordered a dozen 15 x ⅛-inch circular saw blades for a Newton cold saw, an omission in the order caused them to be delivered without the six holes that are usually provided for the reception of the driving pins. An attempt was made to use them as they were but this was found impossible; so it became necessary to find some method of drilling the holes in the hardened steel plates. After every trick known to the trade had been tried, one of the holes was marked out in the place where it was to come and the saw blade at just this point was applied to the surface of a rapidly revolving, fine, glazed emery wheel and held in this position for a few moments. This so effectually drew the temper that the hole was drilled without any difficulty and this way the saws were made available for use.

FIXTURE FOR GRINDING SPIRAL CUTTERS.

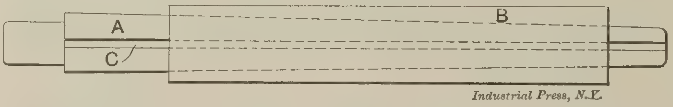
The sketch shows a handy attachment for grinding spiral cutters or reamers; in fact it will be found a great help in keeping any kind of cutter down to the finger rest. The idea is not original with me, but never having seen anything like it in use, I thought it might interest the readers who use cutter grinders. A cord is wound around the shank of the cutter or arbor and carried over a small pulley which, in this case, was attached to a board clamped to the slide. A weight at the end of the cord holds the blade down against the finger rest of the grinder. It will be found to save your temper as well as that of the cutter. K. C. B.



Industrial Press, N. Y.

EXPANDING LEAD LAP.

The sketch shows an expanding lead lap that I have used for many years with great satisfaction. As evident from the cut it simply consists of the taper steel mandrel, *A*, in which a groove *C* is cut the length of the tapered part, and on which is mounted the lead sleeve *B*. Driving the arbor into the sleeve enlarges it and keeps it round and straight. I have used several kinds of lead laps but this is the best of all.



Industrial Press, N. Y.

Assonet, Mass. B. F. Aiken.

NUTS USED AS CHUCKS ON LATHE CENTERS.

I have a shop kink which has served me so well in my work on a lathe that I desire others to have the benefit of it. It is this: Take the lathe centers and cut a thread on the large end according to size—say for one-inch nut (that is the size of my 16-inch swing lathe). The nut serves to pull the center out, and the center is always ready to face any nuts of that size. Extra nuts are used to make all kinds of chucks by turning the nut to fit and driving it hard into the work, leaving ¼ inch on the nut for the wrench. This method saves taking out the centers and removing the faceplate. I have numerous nuts always ready, requiring no change.

Plainfield, N. J. Hiram A. Mears.

REPAIR OF ROCKER ARM.

Some time ago a rocker arm came to our shop to be babbitted and changed somewhat in construction. The casting was bored and babbitted without any means being provided for taking up lost motion. Fig. 1, on next page, is a side view. The part at *a* was bored and babbitted for the pin on the engine and as it was a solid box, the owners wanted it fixed so that all lost motion could be taken up as the bearing wore down. To do this we cut out sections at *b b′* and fitted other pieces in their places so as to adjust radially. As indicated in Fig. 2, the casting was 1¼ inch thick around the bore, and 4½ inches in diameter. After the pieces *b b′* were fitted snugly in place, bands *c c′*, 9-16 x 1½ inch, were shrunk around both ends to stiffen the castings and to hold the setscrews *d d′*, which were provided to set up the movable pieces *b b′*.

What seemed a strange feature of the job to us was the fact that after the bands were shrunk on, the slots were closed in fully 1-32 inch, which made necessary the refitting of the pieces *b b'*. We allowed 1-16 inch shrinkage for the bands, but had no idea that such a thick rigid casting would be so distorted by shrinking on the bands. This feature of the job reminded me of another job that I witnessed some time ago. A water jacket was shrunk around the cylinder of a gasoline engine. The engine was all finished except the jacket, which was a piece of 8-inch pipe. After the pipe was shrunk on it was found that the jacket had contracted the cylinder to such an extent that it was necessary to turn down the piston before it would enter the bore. N. G. B.

Muscatine, Iowa.

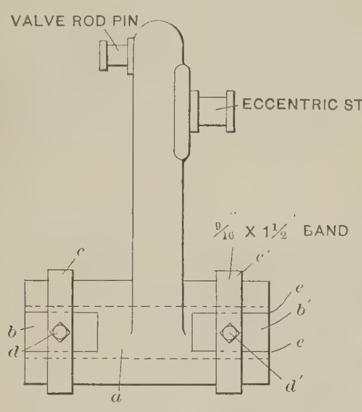
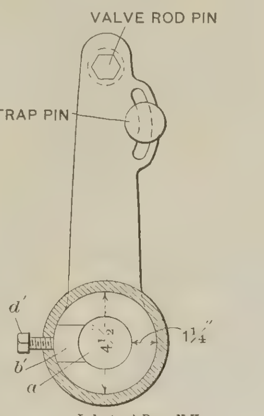


Fig. 1.

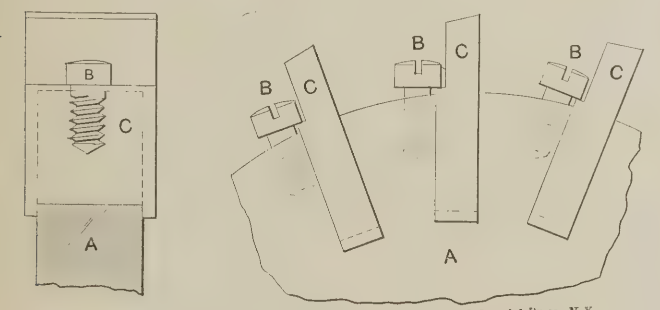


Industrial Press, N.Y.

Fig. 2.

INSERTED-TOOTH MILLING CUTTER.

F. E. R. submits a sketch of an old form of inserted-tooth milling cutter used extensively by at least one New England concern, the Armstrong Mfg. Co. The body of the cutter, *A*, is of cast iron and is slotted for the teeth in the usual manner. The cutters, *C*, *C*, *C*, etc., are made of Howe-Brown steel in this case, and are shouldered for engagement with the screws, *B*, *B*, *B*, etc. The inner ends of the cutters are notched, as shown in the cross-section, to engage the sides of the body and prevent side slip. These cutters work well, are simple to make, and may be used for either radial or end cutting.



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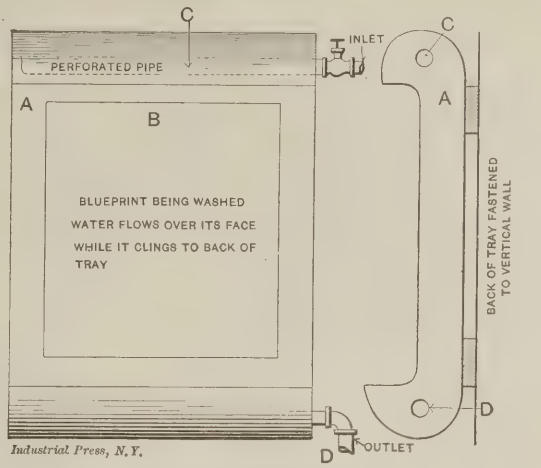
VERTICAL BLUEPRINT WASHING TRAY.

The sketch shows front and end views of a blueprint washing tray used in the drafting room of the King Machine Tool Co., Cincinnati, O., which we would designate as a novelty were it not that it has been used too long for that, at least one other concern having used the same thing for several years. Nevertheless, it is of interest and value, being one of those contrivances that, for some reason or other, has never "caught on," although possessed of considerable merit. It takes up but little room, being fastened to the wall in a vertical position; it is automatic in operation, and the cost is low.

The tray, *A*, is made of galvanized iron so shaped that a hood is formed at the top and a trough at the bottom. The sides are carried to a height of say, 1½ or 2 inches. A pipe, *C*, is carried transversely under the hood, which is perforated on the back side with a row of small holes. The water is thus directed against the back of the tray, where it flows in a thin sheet down over its face into the trough where it escapes at the outlet, *D*. A blueprint to be washed is merely placed against the back of the tray where it clings by the virtue of its "stick-to-itiveness" while the water courses down over its face, washing it thoroughly, and as long as desired without attention.


C
PERFORATED PIPE
INLET
C
A
B
A
BLUEPRINT BEING WASHED
WATER FLOWS OVER ITS FACE
WHILE IT CLINGS TO BACK OF
TRAY
BACK OF TRAY FASTENED TO VERTICAL WALL
D
D
OUTLET

Industrial Press, N.Y.

Vertical Blueprint Washing Tray.

* * *

A REVERSIBLE TAPPING MACHINE.

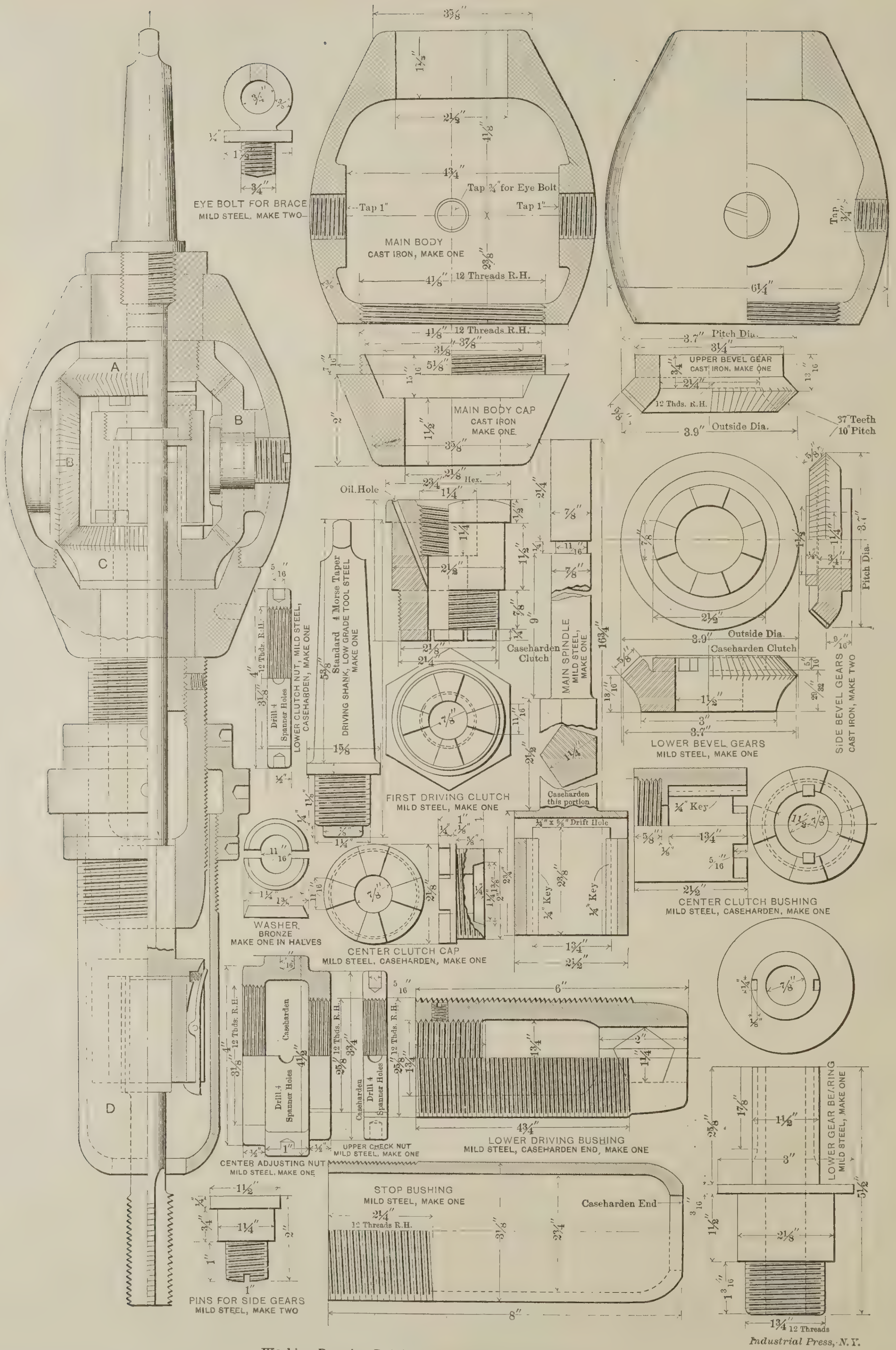
Mr. Fred Harrison, Philadelphia, Pa., has furnished us with the details of the tapping mechanism that is shown on the next page which possesses quite a remarkable record for a mechanism of this kind. It is in use in the Cramp ship yard for tapping condenser sheets and similar work, and in the course of the eighteen years that it has been in service it has tapped about all of the sheets on every vessel that Cramp has made for the United States Government and many others. In all it has tapped over 1,000,000 holes and is still in first-class order.

The device is not as handy for setting to tap a few holes as many of the more modern devices that are now on the market, but for tapping hundreds of holes without changing it has been found to stand up to the work, day and night, as no other device that has been tried. Although rather heavy, it is provided with a brace to suit the machine upon which it is used and is nicely counterbalanced, two eye-bolts being inserted in the sides to provide for attaching the counterbalance.

The working mechanism of the device will be clearly seen by reference to the semi-sectional assembled view that is given at the left of the details. The taps are held in bushings in the end of the main spindle, the capacity of the machine allowing the use of taps ¾-inch up to 1½-inch. The driving shank, of standard Morse taper, fits the socket of the drill press and drives the upper bevel gear *A*, and then, through the medium of the side bevel gears, *B B*, drives the lower bevel gear *C* in a direction opposite to that of the drill spindle. With the main spindle in the position shown, no movement of the tap takes place, but as the device is lowered, the tap encounters the work and causes the spindle to push back the center clutch so that its upper jaws come into mesh with the jaws on the upper driving clutch, and the tap is driven into the work, rotating with the spindle of the drill. The stop bushing *D* is previously set to suit the depth of the hole required, and when the nose of this bushing strikes the work further descent of the device is prevented, so that the tap at once draws down the center clutch out of mesh with the upper driving bushing and thus comes to a stop. The device is now raised for withdrawal and a slight upward movement causes the center clutch to engage with the lower bevel gear and thus rotate the tap in a backward direction.

As will be noticed in following out the details, the tap is not at any time driven through the spindle, but through the bevel gear bushing and the driving bushing, both of which are of large diameter, and thus give a strong and positive drive. All of the gears are in continuous operation so that no stopping of the drill press is necessary; but the mechanism is of such a nature that the tap is brought to a full stop before the reversing parts are thrown into action, so that the tap meets with but little strain on the reversal.

With a ⅛-inch saw, the lower driving bushing is split on



Working Drawing Details of Reversible Tapping Machine.

the five points to within one-half inch of the end. It is then adjusted with the lock nut to suit the strain of the tap so that in case of accident the tap will be free to revolve.

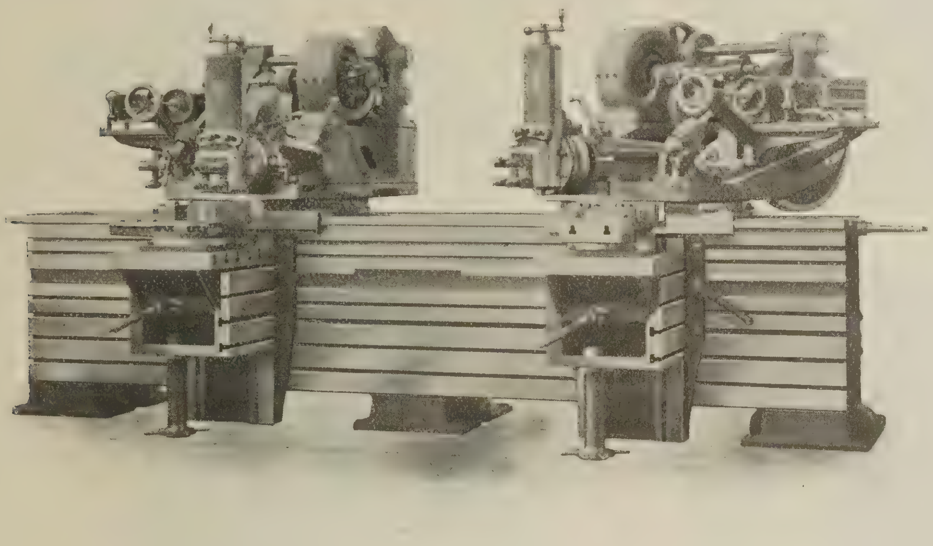
In view of the success with which this device has been used we have reproduced the details in full in order that anyone so desiring can make one for himself.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

DOUBLE-HEAD TRAVERSE SHAPER.

This machine has been designed for machining at one time the two ends of steel beams, or similar work, at angles of from 45 to 90 degrees. The makers call attention to the swiveling saddle, which, they say, is a distinctly new feature. As will be seen, each head is driven by an individual motor. Each of these motors not only operates the ram, but all feeds as well; that is, longitudinal feed to saddle, slow for cutting and fast for traversing, and the power feed to the head, which may be vertical or at any desired angle. There is also a hand traversing feed to the saddles, through the longitudinal screws. There is a hand feed to the head, and a rotary hand feed to the heads, by means of the crank wrench, shown on the right-hand head, through worm and worm gear.



Cincinnati Double-head Traverse Shaper with Motors on Saddles.

The motors and the controllers for operating them are carried on brackets bolted directly on the saddles, and as all feeds are operated from the saddle, the workman, with the controller thus located, has full control over the machine from this one position.

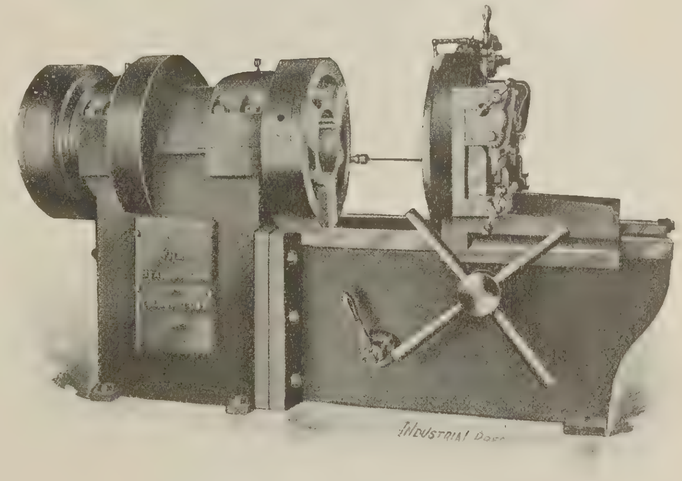
The rams being operated by the well-known Whitworth motion have a quick return. The longitudinal feeds, both slow cutting and fast traversing, are obtained through systems of gearing operating nuts which engage on the longitudinal screws, a system of bevel gears transmitting the motion from the swiveling saddle to the traversing saddle.

The motors are each 5 horse power, of the Crocker-Wheeler, multiple voltage, 3-wire system type. The machine shown is 24 inches by 14 feet and weighs 27,500 pounds net. It is built by the Cincinnati Shaper Company, Cincinnati, Ohio.

PIPE CUTTER AND THREADER FOR HEAVY WORK.

The accompanying half-tone illustrates the design of the "Apex" machine for handling large sizes of pipe. It is manufactured by the Merrell Mfg. Co., Toledo, O. The head column is cast in one piece and an apron is bolted to it. This allows both column and apron to be supported at every point by the floor. The machine is so geared that a separate speed can be obtained for each size of pipe within the range of the machine. The gearing is entirely inclosed within the head column of the machine, is out of the way of the operator and protected from dust and chips. The speed is entirely within the control of the operator, who, moving the lever shown on the front of the apron bed, can change his speed while the machine is in motion, permitting same to thread at one speed and cut off at another. The chucks on both the front and rear of the machine are the same. Projecting jaws are furnished to permit of holding flanges for making up pipe. The chucks are powerful universal chucks, making it unnecessary to tighten each jaw separately; tightening of one jaw centers the pipe and grips it firmly. The head is very massive and the dies are controlled by means of a hand lever attached to a pinion engaging the cam ring which in turn engages the dies. The movement of the hand lever engages or disengages the chasers from the pipe. In setting the dies it is only necessary to loosen the lever from the cam ring pinion and turn the cam ring pinion until the cam adjusts the dies to the size of pipe it is desired to thread, then to tighten the nut on the hand lever.

The head can be moved out of the way of the cutting-off tools, to allow cutting close up to the chuck. The cutting-off blades are two in number, cutting from both sides of the pipe at the same time, saving over one-half the time in cutting off pipe. The use of the geared cam ring, and pinion to operate same, is quite novel and allows of the opening of the dies when engaged in threading without forcing the dies on the pipe as is customary with machines using the toggle-joint locking device. The chasers are very heavy and of unusual width, allowing a proper taper to be obtained for the full length of a standard thread.



Pipe Threader and Cutter for Heavy Work.

SIXTEEN-INCH BACK-GEARED CRANK SHAPER.

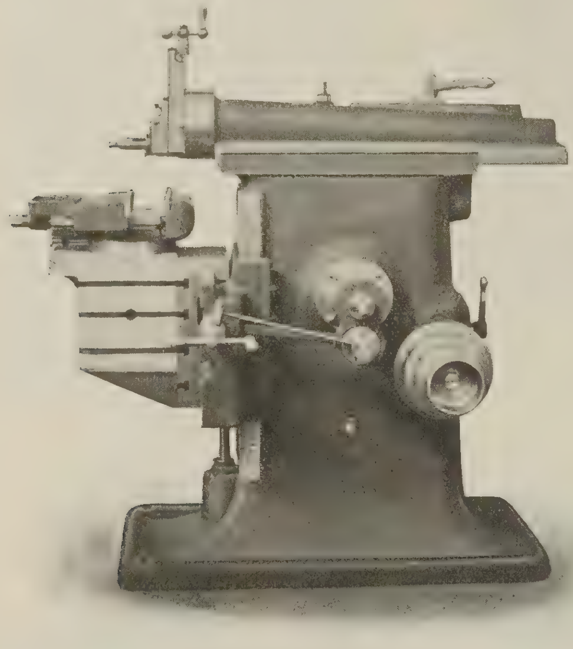
The illustration herewith is of a 16-inch crank shaper built for heavy cutting. The column contains bored seats for the journal boxes of the driving mechanism. The flanged sleeve, which forms a bearing for the crank gear, is fitted with a reinforced section of the column to insure steadiness under heaviest cuts. The top of column extends beyond the face on each end to provide long bearing surfaces for the ram. The surface to which the cross rail is clamped is very wide and deep, giving rigid support to same.

The ram is of semi-circular section—long, wide and deep, and may be adjusted to suit the work while in motion. The tool head has graduated swivel adjustable to any angle, and is securely clamped to ram by two bolts. The down-feed screw is provided with micrometer collar and is furnished with automatic feed, if desired.

The cross rail has a long bearing on column and is made of extra depth and unusually heavy. It is elevated by means of a screw with ball-bearing thrust. The cross feed screw has power feed in either direction and is fitted with micrometer collar.

The cross slide is furnished with gibs, which may be adjusted to prevent lost motion. The box table is secured to cross slide by two studs and one bolt. The studs are screwed in the table near its upper surface and pass through the cross slide at points where it is subjected to the pressure of the cut, relieving this casting of tension strain. The vise may be bolted either to top or sides of table and is fitted with steel faced jaws and a graduated circular base-plate. An index pin is provided to lock the vise when same is set parallel or at right angles with ram. The cross rail, cross slide and table are very deep, which insures rigidity and obviates the necessity for extra support, saving the time required to adjust such a support.

The driving mechanism is arranged for two speeds, which, in connection with the four-step cone for wide belt, gives eight speeds in geometrical progression. The driving shafts are journaled in ring oiling bearings and have large gears with wide faces, which are controlled by lever at the rear of column. Provision is made so that both sets of gears cannot be engaged at the same time. The stroke of ram can be varied while the machine is in motion or at rest, by means of a heavy wrist block. The countershaft is fitted with self-oiling boxes and tight and loose pulleys. Following are the principal dimensions of this machine: Maximum stroke, 17 inches; vertical adjustment of table, 15 inches; cross motion of table, 20 inches; tool block feeding in any direction, 6 inches; vise opens 8 inches. The shaper is built by the Springfield Machine Tool Co., Springfield, Ohio.



Sixteen-inch Shaper.

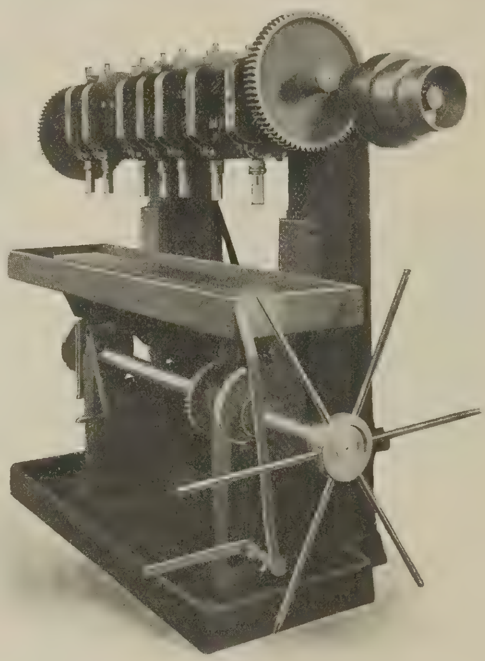
MULTIPLE-SPINDLE GANG DRILL.

The gang drill shown in the half-tone herewith is the latest production of the Moline Tool Co., Moline, Ill. It is made in any length of rail. The one here shown is 7 feet long and with ten heads, the regular heads adjusting to within 2¼ inches of one another to centers of spindles. This size of machine is built for ½-inch drills. Spiral gears, meshing into continuous spirals set in the rail, drive the spindles; and a head may be set in any place or adjusted to any position along the rail without interfering with the drive.

The rail and housings are of box form, and heads are fitted to one V-way and one flat way, making them easy to fit and to keep in line.

The machine is powerfully geared with three changes of speed and three of feed. The table is fed upward by cams; the shaft is driven by worm gearing which can be thrown out at any point when it is desired to operate the table by hand. The cam feed has a quick return and an automatic stop, and the feed can be thrown in either by the hand lever shown or by the foot.

The table has a vertical adjustment of 4 inches, is counterbalanced and has a wide and deep groove for the oil. The spindles have a vertical adjustment of 2 inches, to permit of the use of different lengths of drills. The base of the machine is made in the form of an oil pan. The 7-foot machine here described weighs about 5,000 pounds.

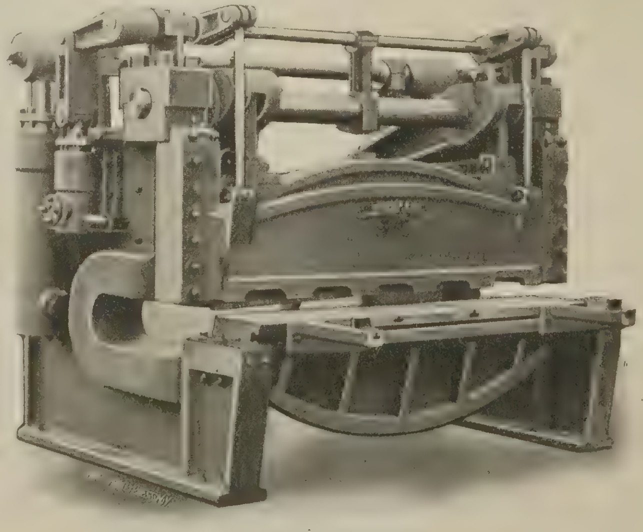


Multiple Spindle Drill.

IMPROVED HYDRAULIC SHEAR.

We illustrate herewith a hydraulic shear manufactured by Bertsch & Co., Cambridge City, Ind., for cutting ¾-inch plates. This is 10 feet in length, with a 30-inch throat. It has a cylinder in each housing with the rams connected directly to the rock shaft by levers. The cylinders are so connected and water so governed that pressure in both cylinders is equal. Pressure in the two cylinders is equal when cutting, owing to the manner in which the cylinders are connected and the water is regulated. Other shears for lighter work are built, having but one cylinder. The advantages of a hydraulic shear are that it can be stopped, started or reversed at any part of the cut. The liability to break from lapping of the blades or the introduction of metal of too great thickness is obviated by the castings and connections being made very strong, so that they will withstand a strain greater than the maximum attainable from the cylinders; consequently, the shear will simply choke and stop without any damage to it.

The cylinders take water in one end, and it is cut off the instant the stroke is made. The knife bar or cross-head and



Improved Hydraulic Shear.

hold-down return by gravity. No water is required to hold them in position when not in motion. No water is used except when actually cutting. The hold-down is operated automatically and adjusts itself to any thickness of metal.

Where factories are not supplied with hydraulic pressure a pump is furnished with the machine and arranged for the continuous use of a small amount of water or oil.

This machine is made any length from 6 to 14 feet, with any depth of throat from 18 to 36 inches, for plates of any thickness from ½ inch to 1½ inches, varying accordingly in weight from 30,000 to 150,000 pounds.

IMPROVED RADIAL DRILL.

Fig. 1 is from a photograph of one size of the line of radial drills made by the Hamilton Machine Tool Co., Hamilton, O. These drills are built in sizes from 2½ to 5-foot arm, and are equipped with various styles of tables, swiveling or otherwise, in addition to the bedplate. Recent improvements have been made in these drills, among which is the geared power feed shown in Fig. 2, which possesses novel features.

The changes in feed are produced by two sets of gears, one of which is the nest of three gears *C*, arranged in a cone, and the other the back gears *E*. These gears are driven directly from the spindle and operated by means of two small levers shown beneath. An attractive point in the arrangement is that the feeds can be easily changed at any time, no matter whether the machine is stopped or in operation.

In feed mechanisms of this description it has been customary to slot the cone gear shaft and to have a sliding feather to throw the different gears into action. This weakens the shaft and in the present instance a departure has been made by arranging the whole shaft so that it will move through bearings at each end and carry the feather with it.

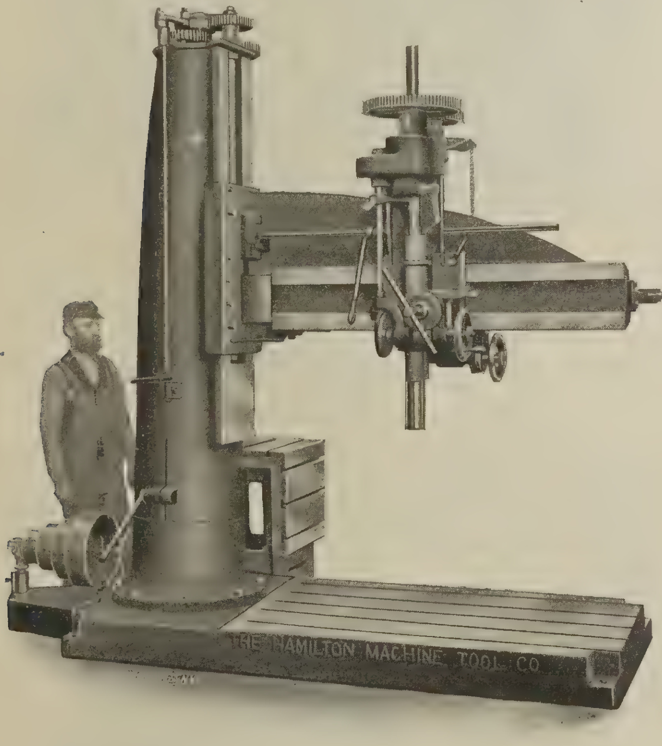


Fig. 1. Radial Drill made by Hamilton Machine Tool Company.

The sliding shaft *A*, contains a movable key *B*, the corners of which are beveled so as to readily pass the adjacent gears when changing from one to the other. By moving shaft *A*, key *B* can be engaged in any of the feed gears *C*, each of which is provided with four keyways. The spring pin *D* is placed so as to constantly exert a pressure on the key sufficient to force it into the keyway whenever the two are opposite. Feed gears *C* are separated by hardened steel collars, so that the key must entirely clear one gear before it can engage another. The shaft *A* is hardened and ground, ample facilities are provided for oiling, and the whole arrangement works smoothly and easily.

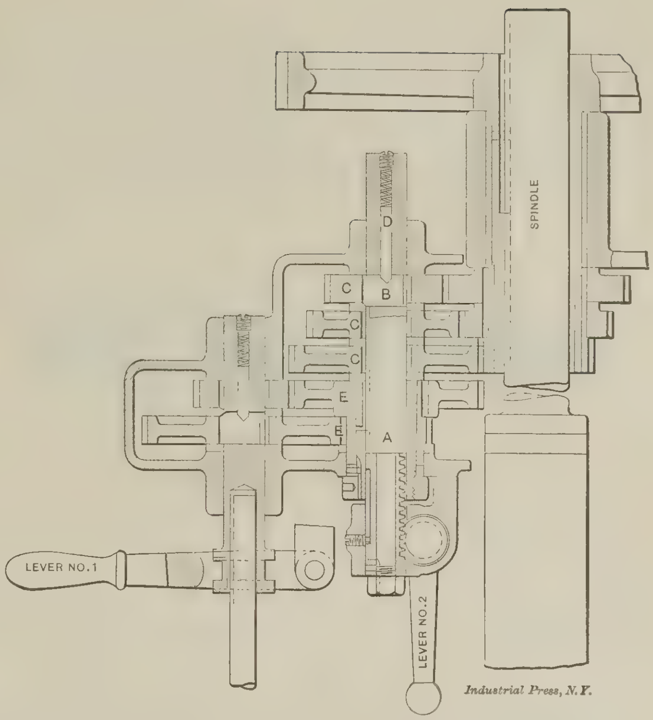


Fig. 2. Feed Mechanism of Radial Drill.

It will be seen that the lower feed gears *E* are friction-driven, the object being to afford a slipping point in case of severe strain, thereby preventing broken gears or more serious damage. The danger of breakage under heavy duty has always been a strong objection to direct-geared feeds, but the adoption of the friction safety release just mentioned, reduces this danger to a minimum. On the 5-foot size which is illustrated there are six feeds for each spindle speed, ranging from .005 to .062 inch.

ADJUSTABLE REAMERS.

Fig. 1 shows a patented universal adjustable reamer recently placed on the market by Schellenbach & Radcliffe, Cincinnati, O. There are three styles of these: The shell, the hand and the machine reamers. The body of the tool is of machinery steel, with taper slots milled to receive the blades, of tool steel. From six to twelve blades are inserted in each reamer and are unevenly spaced. These blades are adjusted by means of the threaded collar on the shank end of the reamer, Fig. 1. The adjusting collar has a groove turned on the inside of the front face of the collar, to receive the tongue milled on the end of the blades. Turning this collar moves all blades simultaneously. To adjust the reamer the binding screws on the blades are released about one quarter turn, which permits free movement of the blades with a spanner wrench, which is furnished. Each blade is held in the body of the reamer independently. The lower front side of the blade has a groove milled parallel to its bottom, and the lower part of groove forms a ledge on the top of which the ends of the screws bear squarely, eliminating side strain on the screws.

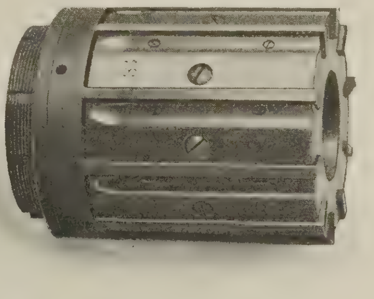


Fig. 1. New Adjustable Shell Reamer.

In Fig. 2 is a roughing reamer, with high-speed steel cutters. The body is of machinery steel, milled to receive the cutters, whose front side, as in the case of the reamer blades, have a groove milled near the bottom and parallel to it, the top of the groove furnishing a ledge upon which the screws seat themselves. The heel sides of the cutters are sufficiently relieved to clear themselves well. The tool is for use in cored work, where considerable stock is to be removed without preliminary boring. The ends of the cutters are ground square and will cut to their bottoms. Adjustment is provided for the end wear of the cutters by driving them forward from the shank end of the reamer.

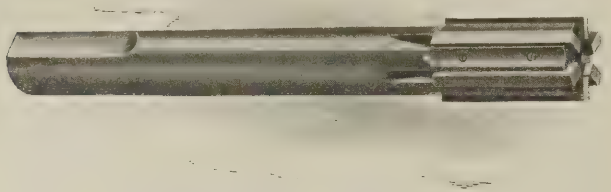


Fig. 2. Adjustable Roughing Reamer.

If started true, these reamers will make a round straight hole, even though the core be considerably out of true. Thus a 2-inch reamer will remove ¾ inch of stock at one cut. The cutters are interchangeable and are built for heavy, hard service. They are made in sizes from 1 inch to 12 inches in diameter, the larger sizes being made in shell form.

UNIVERSAL JOINT.

F. E. Bocorselski, of Springfield, Mass., the inventor of several universal joints, has recently brought out a new one, which is an improvement on the previous ones, and is extremely simple to assemble. This joint has the usual two-forked shaft connections, through which diametrically opposite holes are drilled for the usual pivoted joints. Instead of a solid transmission block, however, to form a connection between the two forked ends, the inventor has made this block in two sections, as shown in the detail sketch. These blocks are made of phosphorus bronze. Each is grooved at *a a*, to fit the pin shown, which passes through the holes drilled in one of the forked members. At the back of each of the blocks is a trunnion to fit one of the holes drilled in the other forked member.

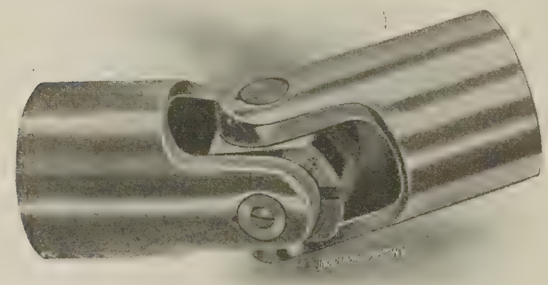


Fig. 1 New Universal Joint of Simple Construction.

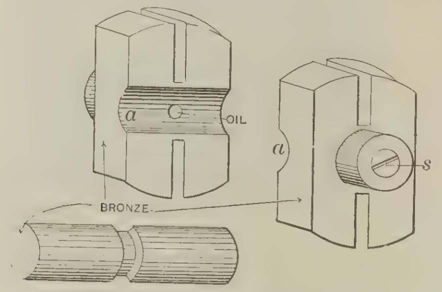


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Fig. 2. Details of Universal Joint.

In assembling the joint the blocks are first put in position between the jaws, the other fork is then slipped over the blocks and the pin is pushed through into place. This pin is grooved at the center for the point of a setscrew *s*, which passes longitudinally through one of the trunnions, thus locking it in position.

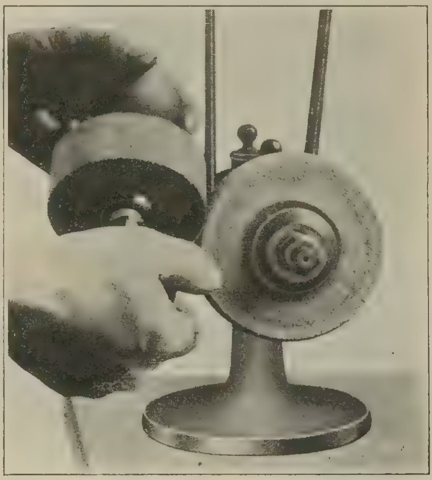
The strength of this or a similar type of universal joint rests ultimately in the capacity of the jaws to resist the tendency of the block to spring them apart under torsional strain. Therefore, a joint built in sections, like this one, has ample strength to transmit power, and has the advantage of easy assembling. The blocks are split, as shown, for the reception of felt, which retains the oil; and felt is also placed between the two blocks for the same purpose.

EMERY WHEEL DRESSER.

A novel emery wheel dresser in which an emery wheel is used in place of the usual diamond point or other device has been brought out by the Heald Machine Co., Worcester, Mass. It is known as the Metcalf emery wheel dresser, and the illustration shows the method of using it.

The device consists of two cast-iron balls at the ends of a short shaft, with an abrasive wheel mounted on a sleeve between them. The balls give weight, which assists in keeping the wheel up to its work, and are held in the hands when the dresser is in use. The success of the device depends upon: First, the inertia due to the weight of the balls; second, the peculiar cutting effect of one abrasive wheel on another when held at an angle of 30 to 40 degrees from the horizontal; and third, the fact that the cutting wheel has a gyroscopical action tending to hold it always in its own plane.

It is found that this dresser cuts out the bond or filling between the abrasive particles of the wheel and leaves the latter standing out on the surface in the best possible condition for rapid grinding. A special advantage is that by its use a sharp corner can be brought up on thin or delicate wheels, as it does not have a tendency to break off the corner. It is also of use in freshening up the face of a wheel when glazed over, even if it is not desired to true up the wheel.



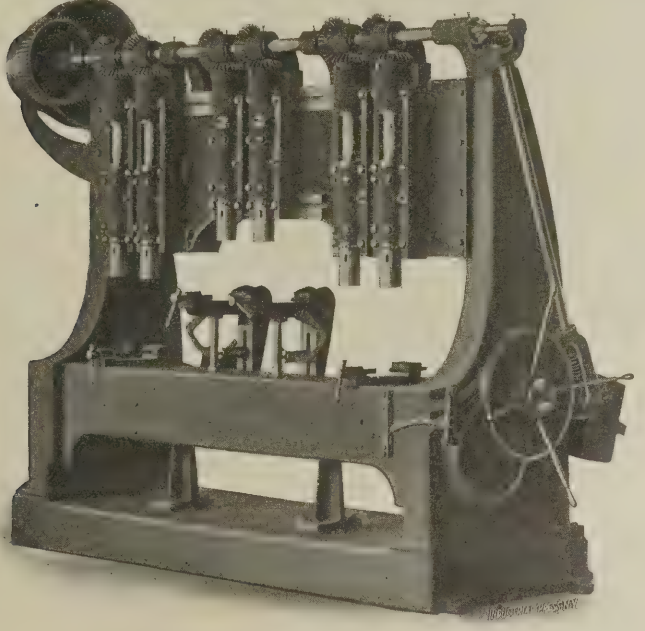
An Emery Wheel used for Truing an Emery Wheel.

Provision is made for taking up wear and also for preventing dust from entering the bearings of the dresser, as well as for holding a supply of oil sufficient to thoroughly lubricate the bearings. The wheel used on this device has a 1½-inch face and is 3½ inches in diameter.

MULTIPLE SPINDLE DRILL FOR HEAVY WORK.

A multiple spindle drill for heavy work of a special character is the arch bar drill made by Foote, Burt & Co., Cleveland, O., which we illustrate. The uprights are cast in box form and are exceptionally deep. Each head has a 5-inch vertical adjustment so as to bring the drill points in the proper relative position regardless of whether the work is even or irregular. The cross rail is a solid web I-beam section, with cross girts on the back, and is provided with surfaces on the front to support the several heads. This cross rail is unusually rigid, to avoid deflection. The table is fed up to the drills by a rack and pinion, feed shaft being 2¾ inches in diameter, supported in each upright and in the center by two bearings. The feed rack is 4-pitch, 3 inches face. The miter gears which drive the spindles are of forged steel with planed teeth. The drive miter on each head does not depend on the drive shaft for support, but it is housed in a heavy bearing directly connected to the saddle, and in addition to these the drive shaft is supported at four points as well as where it passes through the miter gears. The miter gears being supported in this way form a part of the head, so that when it is desirable to move the saddle for different spacing of the spindles the driving miter is carried with it. On some of the older types of this tool the saddle had to be adjusted, and the driving miter brought up separately to mesh with the driven gear, where it was fastened by a set-screw to the driving shaft, bringing the whole strain on the shaft.

The feed mechanism is extremely heavy throughout, and the whole design of the machine is such that high-speed and fast speeds can be used without straining the machine or without any apparent deflection up to the limit of the drills themselves.



Heavy Arch Bar Drill.

The capacity of the machine is for 1⅞-inch drills in any material and the spindles are 2¼ inches in diameter, making it one of the heaviest multiple spindle machines that is now built. The thrust of the drills is taken by 4-point ball bearings, with balls ⅝ inch in diameter.

PLANER RAIL ELEVATING DEVICE.

A new power elevating device has been adopted by the Cincinnati Planer Co., Cincinnati, O., for raising or lowering planer rails. The device is the invention of their superintendent, Mr. George Langen, and is operated by an improved type of friction clutch in place of the usual tumbler gears. Corresponding parts are numbered the same in the half-tone and line drawings and are as follows: 1 is the pulley shaft; 2, the driving pinions; 3, the perforated bushing driven into the driving pinions; 4, the split clutch ring; 5, a steel sleeve secured to the pulley shaft by means of a taper pin. 2 and 7 are the raising gears, while 2, 8 and 9 are the lowering gears, which are proportioned to give a higher speed than those used in raising.

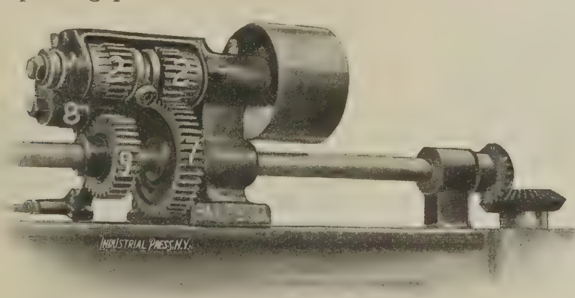
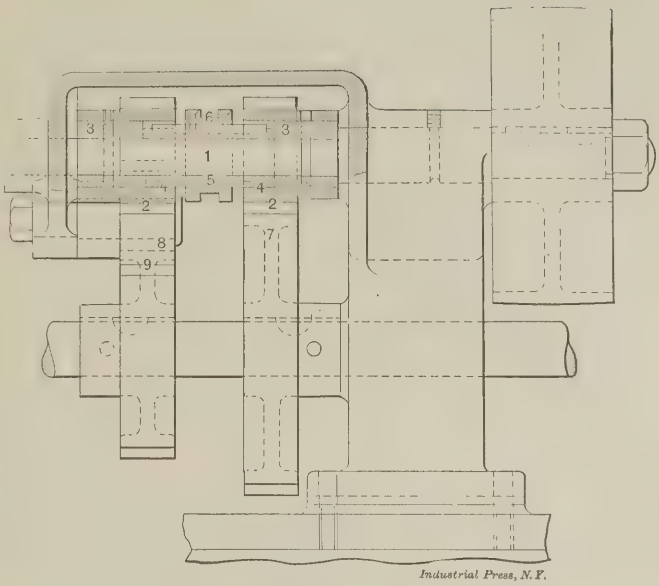


Fig. 1. Elevating Device for Cincinnati Planer (Patent Pending).

It will be noted that the ends of the steel sleeve 5 are turned down so that each end fits loosely into the split ring, 4, the center being left larger in diameter so that the wedge rings cannot pull out of the gear hubs. The steel sleeve 5 is splined its entire length, and the collar 6, which operates the clutch, has a key secured to it which slides in the spline and is tapered on each end to fit the taper opening into the wedge rings and thus expands the latter. It will be noted that the design of sleeve 5 is such as to make it a simple method for holding the split rings in position.



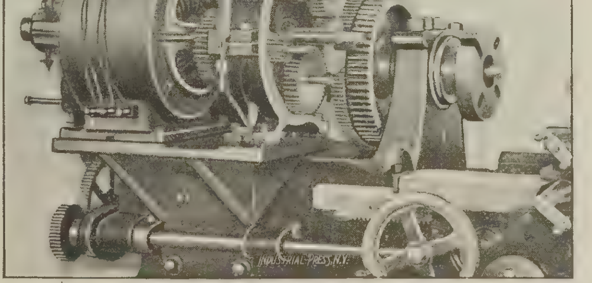
Industrial Press, N.Y.

Fig. 2. Drawing of Elevating Device.

When applied to the planer, the device is so located on the arch as to bring the raising gears directly on the center of the machine, so as to distribute the strains equally. The bracket supporting the gear also forms a center bearing for the elevating shaft. The mechanism is operated by a long handle which gives sufficient leverage to bring the device under absolute control, and it is possible to raise or lower the lathe to within scratch line of the housing. This handle is locked in position when not in use.

VARIABLE SPEED DRIVE.

The illustration herewith shows the head end of a standard lathe fitted with a Johnson mechanical speed control and a constant speed motor. The controlling apparatus is made by the Israel H. Johnson, Jr., Co., Philadelphia, Pa. This device takes the place of the usual countershaft and like the countershaft it operates at a constant speed, while the lathe spindle is driven by gearing which gives the equivalent of a 5-step cone pulley with back gearing.



Lathe Fitted with Variable-speed Drive.

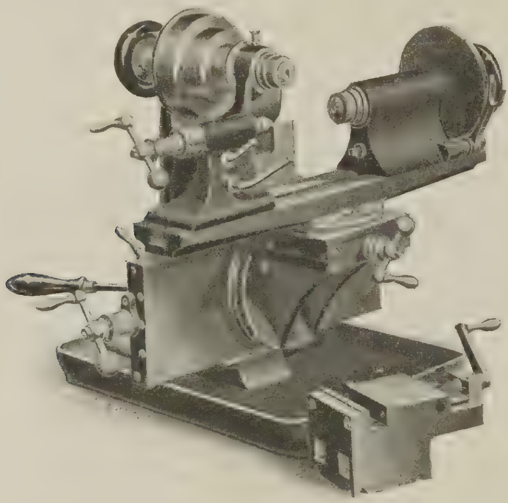
The only alteration necessary in the lathe itself is the removal of the cone pulley (whatever number of steps) and a substitution of a simple sleeve having the usual back-gear pinion on one end and at the other end a gear occupying the position of the largest step of belt cone. Connection between this sleeve and the spindle is made as in the standard lathe with cone, giving five speeds direct through spindle and five through the back gearing.

The speed control gearing has five gears mounted on shafts which pass through long bearings and carry other gears at their opposite ends.

Speed changing is accomplished by rotating the gearing housing so as to bring the desired set of gears into driving position, which is done by different methods for different sizes of speed controls. By this arrangement changes of speed are made more easily and quickly than by shifting a belt upon cone pulleys especially where the change is more than one step. One point of note in this control is that for each driving position only one pair of gears is in action, all idle gears remaining at rest.

A BENCH MILLING MACHINE.

A bench milling machine for small and accurate work has been brought out by the Sloan & Chace Mfg. Co., Newark, N. J. The elevating device of the saddle and knee is operated by a handwheel at the rear of the machine through a bevel gear and elevating screw, which thus enables the greatest knee travel possible for a given height of machine. The knee slide can be operated either by a rack and pinion or by a screw. The device for this purpose consists of a hand screw working in a cylindrical nut, with rack on one side engaging a toothed sector, to which a long handle is attached. When the nut is clamped to the knee the screw feed can be used, and when the clamp is released the slide is actuated by the long handle, which gives a sensitive lever feed. The knee and the carriage both have full circle graduated bases, one of which is in a horizontal and the other in a vertical plane. The spindle cone is for a 1-inch driving belt, and the machine has a vertical travel of 4 inches, horizontal of 8 inches, and a cross travel of 2¼ inches. The vise jaws ar 3¼ inches long and ¾ inch deep.



Bench Miller of Improved Construction.

TWENTY-INCH GANG DRILL FOR DRILLING AND BORING

The most recent development of the gang drill is its adaptation for drilling, boring and reaming pieces of work which ordinarily would be machined in a chucking machine. The evident advantage of a multiple spindle drill for such work is that more than one tool can be in operation at the same time. Inasmuch as different periods of time are required for the different spindles to perform the various operations upon a piece, the operator has an opportunity to set the work in position under each spindle, and so keep all of them in operation at the same time, as against a single spindle of the chucking machine.

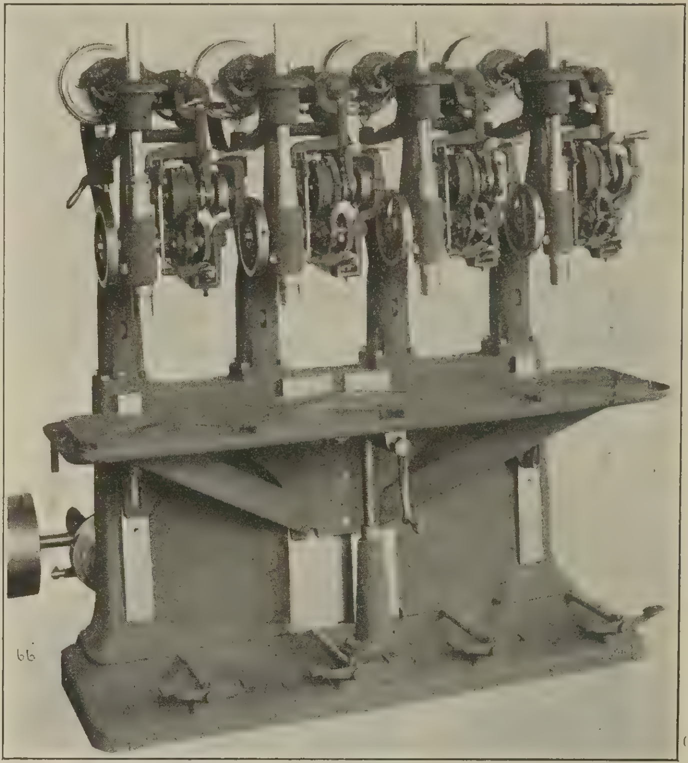


Fig. 1. Gang Drill for doing the Work of Chucking Machines.

The drill shown in the accompanying illustrations is made by the W. F. & John Barnes Co., Rockford, Ill. When the drill is in operation the attendant moves a lever, and the spindle instantly drops to the work and starts the drill, and when through automatically goes back to its original position. This operation can be repeated as fast as the pieces are changed and the action is the same for each of the several spindles. The machine is driven by one belt, each spindle, however, being independent of the others so that all can be operated at one time or individually.

The second illustration shows the arrangement of this driving mechanism which consists of a horizontal shaft near the floor, connected by bevel gears with a cone pulley for each spindle. The bevel gears are thrown into or out of operation by friction clutches which are operated from the front of the machine by the foot levers shown in the first illustration.

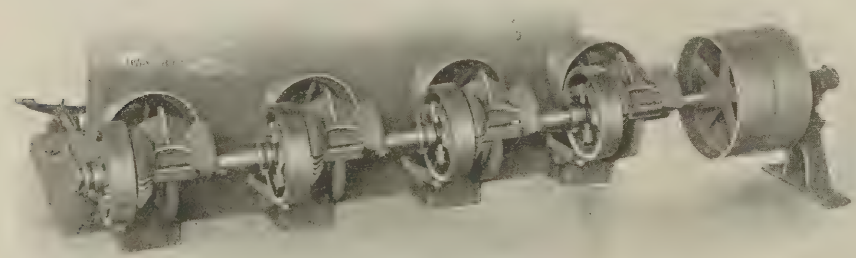


Fig. 2. Showing how all the Spindles are Driven from the same Shaft.

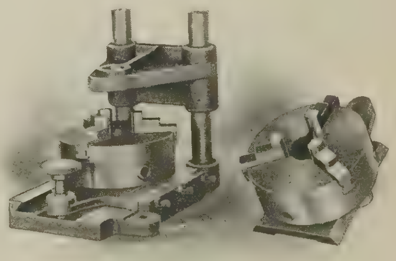


Fig 3. Chuck used in Drilling.

The universal sliding chuck shown in Fig. 3 is designed for use with this machine. The chuck is centered underneath the drill bushing by means of a taper pin. The chuck and its work are carried by a slide which can be withdrawn and placed under the different spindles for successive operations, and the chuck will always be centered.

This gang drill is made in two styles: One with the auto-

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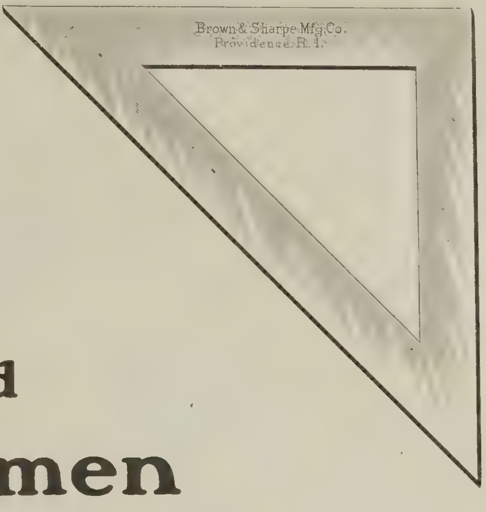
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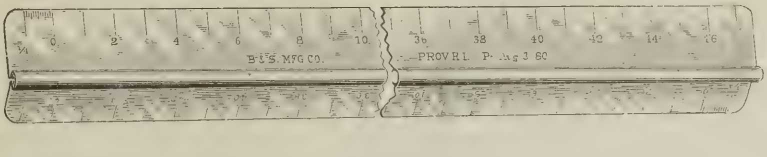
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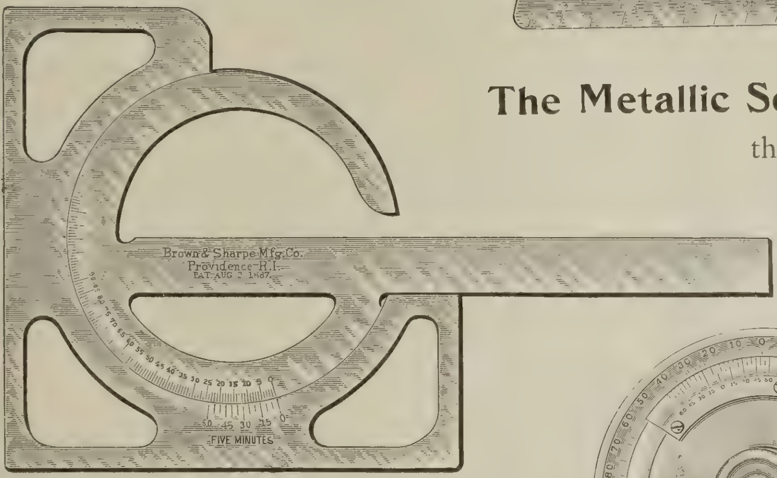
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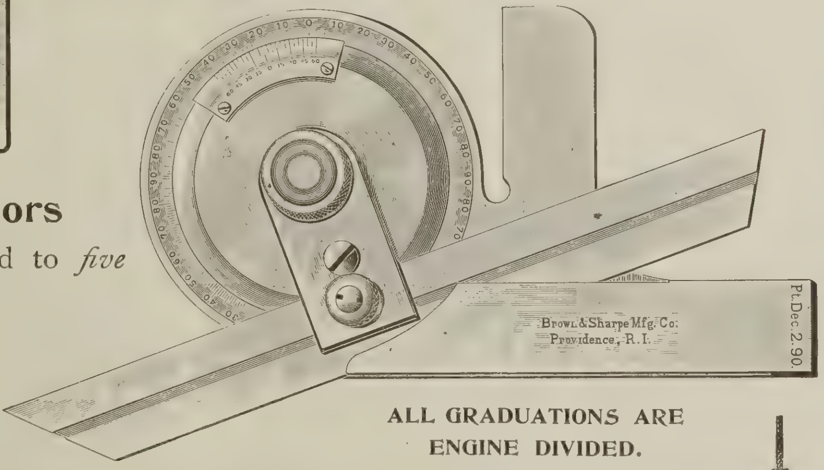
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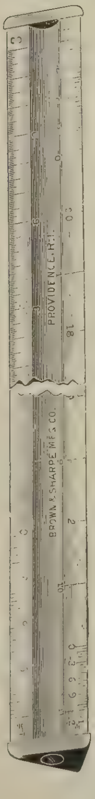
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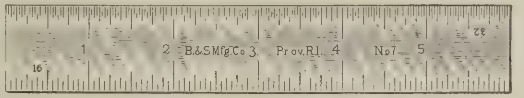
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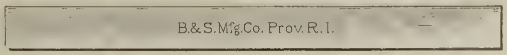
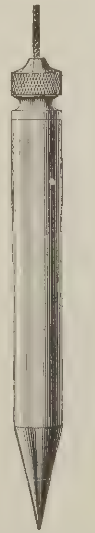

B. & S. Mfg. Co. Prov. R. I.



These Tools are carried in stock by all Leading Hardware and Instrument Dealers.

The Rules are as nearly exact copies of U. S. Standards as expert mechanical skill, aided by special Machinery, can make them.

1904 Catalogue mailed to any address upon request

SEE PAGE 87

matic approach and return feed, as described, and the other with a regular self-feed such as is usually provided with vertical drills. Any of the spindles may be supplied with back gears or not, as desired, and with lever feed, worm feed, automatic stop, reverse motion for tapping, etc. Also with two, three or four spindles.

As an example of what the machine accomplishes with the chuck attachment, the builders state that they have chucked, bored and reamed 200 10-inch pulleys in ten hours on a 3-spindle gang drill having automatic approach and return feed on each spindle. The pulleys have a 1 7-16 inch hole, 2¾ inches long. In accomplishing this work two high-speed drills and one reamer were employed, and both the drills and the reamer were run through each pulley.

* * *

FRESH FROM THE PRESS.

Hendricks' Commercial Register, of the United States. Thirteenth annual edition. Published by the S. E. Hendricks Co., 76 Elm St., New York. Over 1,300 pages. Bound in cloth. Price $6.00.

This book includes all professions and trades interested directly or indirectly in the mechanical, electrical, architectural, engineering, power transmission, railroad, iron, steel, foundry, machine shop, hardware, implement, heating, plumbing, mill, mining, and similar lines. There are 350,000 names and addresses classified under 12,000 classifications. The work gives the names and addresses of the manufacturers and dealers of everything made from iron, steel, brass, bronze, aluminum, clay, stone, marble, granite, slate, wood, fiber, asphalt, asbestos, etc.

The *Patternmaker* is a new journal published by the Iron & Steel Press Co., Cleveland, O., the publishers of the *Foundry* and the *Iron Trade Review*. It is to be of the same size and style as the *Foundry* and will undoubtedly supply the wants of patternmakers, who have heretofore had very little published for their benefit. There is no reason why as interesting matter should not be written on patternmaking as on machine shop practice, for example, or on foundry work, and we believe that patternmakers will be as glad to welcome such literature as have been their fellow workers in the other fields. The journal is to sell for $1.00 a year, and it will afford an opportunity for manufacturers of patternmaking machinery and supplies to get into closer touch with foremen and workmen in pattern shops, who undoubtedly influence purchasing to considerable extent and who themselves will be glad to become better acquainted with new products as these are placed on the market.

We have previously taken occasion to make favorable comment on the instruction papers upon mechanical drawing prepared by Prof. Chrales L. Griffin, for the American School of Correspondence, Chicago. Prof. Griffin has since ceased teaching and has gone into commercial work. He retains his skill and originality in imparting information to students, however, as is shown by a new textbook on machine design which is now being used by the American School of Correspondence. The treatment of the subject is entirely novel, departing from the stereotyped plan adopted by most of the writers on this subject. He has in effect placed a notebook in the hands of students containing practical directions for machine design such as he might tell them by word of mouth, giving them also wholesome advice apart from the specific directions for making calculations and drawings. The treatise is to be issued in sections, and the first part—which is the only one that has yet appeared—is devoted largely to the design of a rope driving machine in connection with an elevator, the machine being operated by an electric motor. This includes, of course, a number of distinct problems, such as power transmitted by rope driving, the design of rope sheaves, band brakes, bearings, frames, motor connection, etc. The different parts of the problem are worked out from the rough preliminary sketch to the complete detail working drawings. The calculations are reproduced as they would be made by a draftsman in his notebook, and a student who went through this one problem would have a good general idea of the way in which the design of a machine should be worked out, and of the method of supplying data relative to the strength of materials.

The treatise is to be had only in connection with the course of instruction, and is not for sale as a text book.

How to Measure up Woodwork. By Owen Maginnis. 79 pages, 5 x 7¼ inches, and 161 figures. Published by the Industrial Publication Company, New York. Price 50 cents.

This book, as the title indicates, gives directions for measuring up the woodwork for buildings. This of course includes the rough lumber for framing, sheathing, studding, etc., and the interior finishing work such as door jambs, base and trim, doors, flooring, molding, window sash, frames, etc.

Fowler's Electrical Engineers' Year Book and Directory of Electric Light, Power and Traction Stations in the United Kingdom. 481 pages, 3¾ x 6 inches, illustrated. Published by the Scientific Publishing Company, Manchester, and sold by Derry-Collard Company, New York. Price 70 cents.

This is not a work for the electrical amateur but is a valuable reference book for electrical engineers, street railway managers, lignting engineers, etc. Although the binding and paper are of inferior quality the presswork and general typographical appearance are good, which, together with the very low price, undoubtedly makes this book one of the best value for the money to be had on the subject.

Friction and Lost Work in Machinery and Mill Work. By R. H. Thurston, late director of Sibley College, Cornell University. Seventh edition enlarged. 442 pages, 6 x 9 inches, and 77 cuts. Published by John Wiley & Sons, New York. Price $3.00.

A considerable amount of new matter has been added in the seventh edition of this well-known work, bringing it up to date. Of special interest is the discussion of high-speed bearings such as are now coming into use with the steam turbine. This includes reference to the experiments made by Lasche, which were carried to rubbing velocities as high as 3,900 feet per minute. The variables affecting high-speed lubrication as determined by Lasche, are exhibited in Cartesian three-co-ordinate diagrams. The chapter on the inspection and test of lubricants is one of great value to every user of oil, especially, of course, to large buyers. But the small buyer needs to know the quality of the oil he uses, since an inferior quality may seriously affect his production without the real cause being suspected, or at least known for a certainty.

Mechanical Engineers' Pocketbook. By D. K. Clark, fifth edition revised throughout and enlarged by H. H. P. Powles. 692 pages, 3¾ x 6 inches. Illustrated. Published by D. Van Nostrand Company, New York. Price $3.00.

This favorably known English compilation by the late David Kinnear Clark, who died in 1896, has been revised and brought down to date by Mr. H. H. P. Powles. The section on electrical engineering has been re-written with additions so as to adapt it to recent developments in this comparatively new science so far as it affects industries. The tables and cuts are clear and well printed on a good quality of thin paper, which latter has made it possible to get a large quantity of valuable data into a comparatively small book. In fact it more nearly approaches being a "pocketbook" than some other so-called pocketbooks, which name, of course, has become a misnomer with their increased bulk. The Clark pocketbook is a valuable addition to the engineer's working library, as it gives data on English practice not found in American works.

Points for Buyers and Users of Tool Steel, by George W. Alling. 224 pages, 5¾ x 8 inches, and 66 cuts. Published by the David Williams Company, New York. Price $2.00.

When, as regards the shop, it is considered that the function of all machine tools is to hold and traverse a cutting tool across the surface of the "work," and that the efficiency of machine tools in general, in the past at least, has been limited by the capacity and effectiveness of the steel used in the cutting points, it is apparent to all that the subject of tool steel is one of the first importance to the buyer and user. Of still greater importance, if possible, is the subject to the manufacturer of edged tools, taps, reamers, dies, etc. As the author truly says: "The ignorance of the steel workers has made many fortunes for the steel manufacturers, and probably will make many more." The book is divided into two parts, the first part is more for the buyer, telling how various steels are made; why good steel is high-priced; how to choose the best for your use; why cheap steel is expensive to use; defects in steel and how produced; steel for miscellaneous tools and parts, etc. The second part gives many valuable points on working steel; tells how to detect imperfect steel; various methods of annealing steel; preparing steel for hardening; hardening and hardening appliances; "high-speed" steels and their treatment, etc. The history of alloy steel practically begins with the discovery made by Robert F. Mushet in 1868, when striving to improve the quality of Bessemer steel, which resulted in Mushet's special and Mushet's self-hardening steel, now well-known throughout the machine shop world.

NEW TRADE LITERATURE.

C. A. Nordquist, 39-45 W. Randolph St., Chicago, Ill., manufacturers' agent for the Chicago adjustable boring tools. Pamphlet descriptive of this tool, with cuts illustrating tools, Nos. 2 and 4. It is stated that this is a universal tool for any and all boring done on a lathe, and that only two different holders are required to fit all lathes over 12-inch swing. This tool was recently illustrated and described in our reading columns.

The Colburn Machine Tool Co., Franklin, Pa., builders of machine tools. Catalogue "A," illustrating the Colburn universal saw table, with description of its distinctive features. Fine half-tone engravings show the saw table tilted in the different positions for various kinds of work such as, sawing miters for square frames, sections for triangles, for hexagons, octagons, sawing out round core boxes, sawing compound or flaring angles, sawing bevels, newel posts, etc. This saw table was described at length in Machinery some time ago.

The Crocker-Wheeler Co., Ampere, N. J. Advertising literature in the form of flyers descriptive of the products of the company. These pamphlets treat of the Crocker-Wheeler multi-voltage system of electric driving, and illustrations show motors applied to Band saws, Bolt cutters, drill presses, mud ring drill, lathes, milling machines, shapers, horizontal boring machine, boring and turning mill, punch and shear, plate bending rolls, etc., Also Bulletin No. 40, which describes the motors manufactured by this company for driving traveling cranes and hoists. A half-tone shows a 10-ton revolving crane, using 5 "Form K" motors for the various movements.

MANUFACTURERS' NOTES.

The Cling-Surface Mfg. Co., Buffalo, N. Y., report healthy foreign business, good orders coming in from Mexico, England, Russia, Hawaii, Australia.

The Northern Engineering Works, Detroit, Mich., builders of electric and hand power cranes, have increased their capital stock to $150,000.

Mr. W. L. Cheney wishes to thank those with whom he has been in correspondence, for their attention, and to announce that he has entered the service of the Lucas Machine Tool Co., Cleveland, O.

H. A. Norton, of the firm of A. O. Norton, 286 Congress St., Boston, Mass., manufacturer of the "Norton" jacks, sailed on the steamship Canopic on January 30, for the Mediterranean and a trip up the Nile—business and pleasure combined. He expects to be away about four months.

The Robertson Mfg. Co., Buffalo, N. Y., manufacturers of the Robertson rapid cut power hack-saw, have made further improvements on the power hack-saw illustrated in the July, 1903, issue. This machine is now made in three sizes, the largest having a capacity 8 x 8 inches. The latter size machine is said to be particularly valuable for cutting off steel gear blanks in all sizes up to 8 inches diameter.

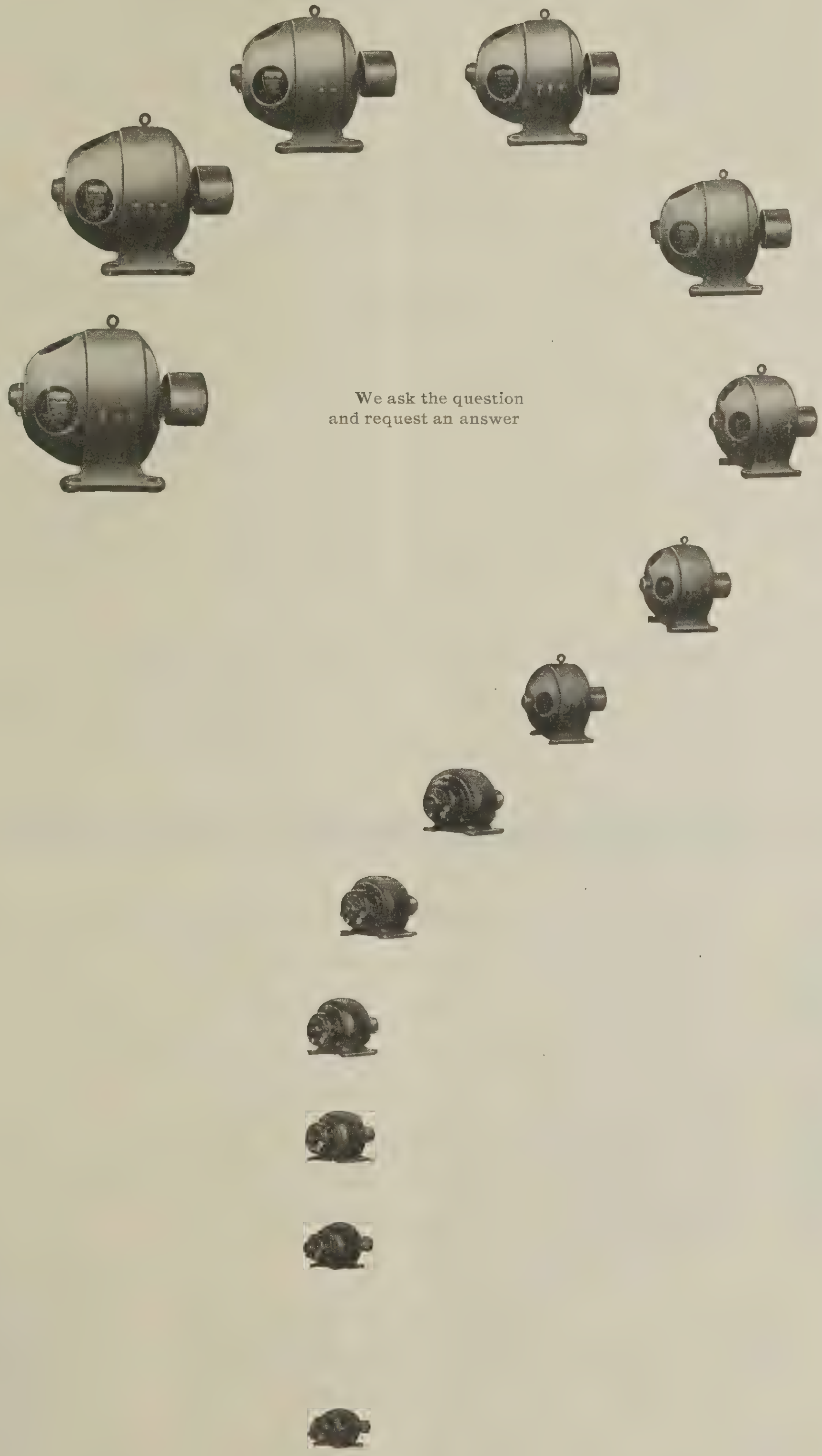
The Poole Engineering & Machine Co., Baltimore Md., inform us that their works at Woodberry were not injured by the recent destructive fire in Baltimore, but that their office on German Street was entirely destroyed. The books and valuable papers were saved, however, and the entire office force has been combined at Woodberry in a new fireproof office building erected by the company for its own use.

The Goldschmidt Thermit Co., is the name of a corporation formed under the laws of the State of New York for exploiting in America the alumino-thermic process invented by Dr. Hans Goldschmidt and protected by U. S. patents. They propose to conduct business generally in connection with the Chemical and Tin Smelting Works of Th. Goldschmidt, Essen-Ruhr, Germany, (founded 1847) and are prepared to handle all products dealt in by the parent concern.

The McCullough-Dalzell Crucible Co., Pittsburg, Pa., importers of plumbago and manufacturers of crucibles, have sent us a list containing the names of the importers of plumbago into the United States from Ceylon during the year 1903, compiled by the L. C. Hopkins Co., weighmasters. According to this list, among eleven large importers the McCullough-Dalzell Co. stand third highest as importers of this product in large quantities.

The Trenton Iron Co., Trenton, N. J., announce the issue of the four following publications: "Wire Rope and Its Application to the Transmission of Power, etc.," which contains information of a general character on this subject, is illustrated, and contains a number of useful tables; "Wire Rope Tramways," also illustrated, treating of the Bleichert system of wire rope tramways, of which this company are the manufacturers in the American continent; "Cable Hoist-Conveyors," containing 37 pages on the subject of hoisting apparatus, calling special attention to the Laurent-Cherry and to the Hall patent systems of conveying; "The Application of Wire Rope to Surface and Underground Haulage," a reissue of the chapters on the same subject in a previous publication entitled "Wire Rope Transportation in all its Branches." The company state that any or all of these will be mailed free of charge to interested applicants.

Do You Use Motors



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* * *

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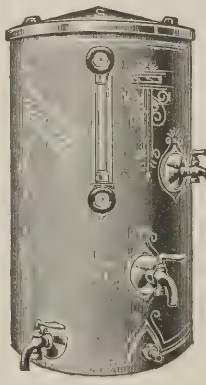

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MACHINERY.

April, 1904.

VARIABLE SPEED MOTORS.—1.

TYPES MADE BY THE GENERAL ELECTRIC COMPANY.

WM. BAXTER, JR.

Wm. Baxter, Jr.

Variable speed machines of every kind have always been driven from shafts running at a constant velocity, and all the speed changes required have been obtained by means of mechanical devices that as a rule form part of the machine. In the direct-connected motor-driven tools which are continually growing in favor, the old practice is considerably modified, the speed variations being obtained, in part or in whole, by varying the velocity of the motor. Many persons, not familiar with the operation of motors suppose that they are essentially constant speed machines, but such is not the case. A series wound motor is a variable speed machine, and its velocity will decrease as the load increases. A shunt wound motor will run at a nearly constant speed with any load from zero up to its full rated capacity, provided it is proportioned so as to attain such a result. Compound wound motors will also run at nearly a constant velocity. Alternating current motors of the induction type, which are the only ones suitable for driving machinery, can be proportioned so as to run at nearly a constant velocity with load changes, or they can be proportioned so that the velocity will drop as the load increases. Shunt and compound direct current motors, and induction motors can be provided with controllers by means of which the speed may be varied in any manner desired. In considering the question of speed variation the points of importance to be decided are as to the most economical and desirable method, all things considered, and also as to the extent to which it is advisable to carry the speed variation.

As to the extent of variation in speed that is possible it can be said that it is unlimited, that is, if the normal velocity is, say, 1,000 it can be reduced to one revolution per minute, or it can be increased to a point where all the power of the motor is absorbed in overcoming the resistance to rotation, provided centrifugal force does not throw the armature to pieces before this velocity is reached. It being possible, therefore, to vary the speed to any extent, the question is, how much of a variation is profitable? In many cases it is necessary that the torque remain nearly constant at all speeds, hence the power developed by the motor will vary directly as the velocity. A great many persons who do not give the subject proper thought consider that this is a feature peculiar to motors, and that it is a point against them; but a moment's reflection will show that a steam engine will act in the same manner, that is, if the steam pressure and point of cut-off remain unchanged, the power will vary directly as the speed. In a steam engine the power can be varied by varying the pressure, and in like manner the power of a motor can be varied by varying the voltage of the current that drives it.

If we desire to obtain a speed variation of five to one with constant torque, the power of the motor at the high velocity will be five times as great as at the lowest, from which it follows that at the latter speed the motor is five times as large as it need be if the change in velocity were obtained without reducing the motor speed, in other words, by means of gearing. Changes in speed obtained by means of the motor are gradual and can be effected without stopping the machine, hence they are more desirable than changes obtained by means of gearing, and this advantage offsets the increased size of motor required to effect the speed variation. In deciding to what extent speed variation shall be obtained by means of the motor, the advantages derived therefrom must be weighed against the greater cost due to the increased size of motor.

There are three systems of control commonly used to vary the speed of continuous current motors, the rheostat, the field regulation and the multivoltage systems. The General Electric Company furnishes motors and controllers to operate under all these systems.

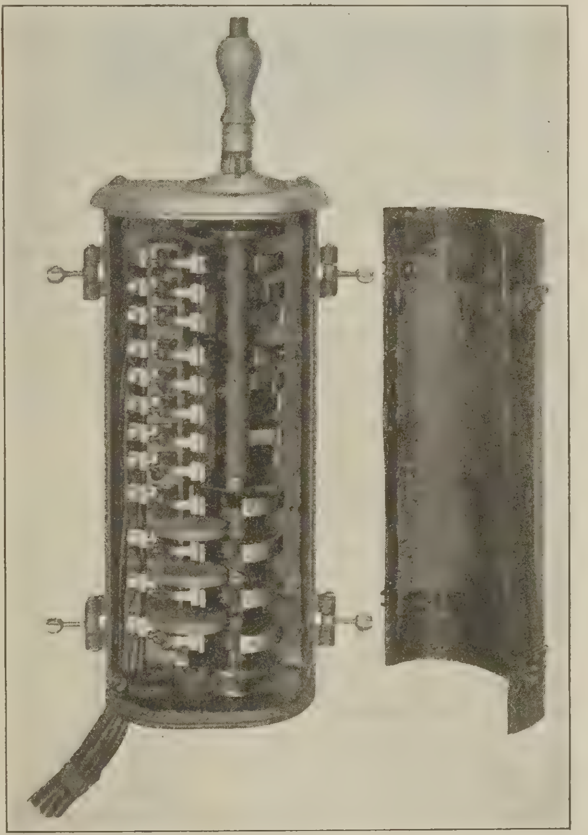

Fig. 1. General Electric Type of Controller for Field Regulation.

The rheostat control is the simplest of all methods of regulation, but is at the same time the most inefficient, owing to the fact that the reduction in velocity is obtained by introducing resistance in the armature circuit, and this resistance absorbs electrical energy at a rate that is substantially equal to the reduction in speed; so that the amount of energy required to run the motor is practically the same at all velocities. There is another objection to the rheostat controlling system that is not generally taken into account, and which, perhaps, is not so well understood as it should be. This objection is that when resistance is introduced in the armature circuit of a shunt or compound wound motor, the self-regulating property is impaired; that is, the motor will no longer run at a substantially uniform velocity with light and heavy loads. If the resistance introduced in the armature circuit is small, the effect upon the regulation is not very great, but it becomes sufficient to be decidedly serious if the resistance introduced is enough to effect a large reduction in speed. Owing to this interference with the speed regulation, if a motor provided with the rheostatic control is used to operate a tool that does intermittent work, for example a lathe turning off the side of a crank, the speed will drop when the tool is cutting, and will increase as soon as the tool leaves the work. Under these conditions, if the resistance in the armature circuit is large, the motor may speed up so much by the time the tool reaches the work again as to break or grind the point away. If the lathe is used to face off pulleys, or for any other work in which the cut is continuous, the only objection to the rheostat method is its low efficiency, otherwise it is equal to any speed varying system, as it gives any velocity from the normal motor speed down to zero.

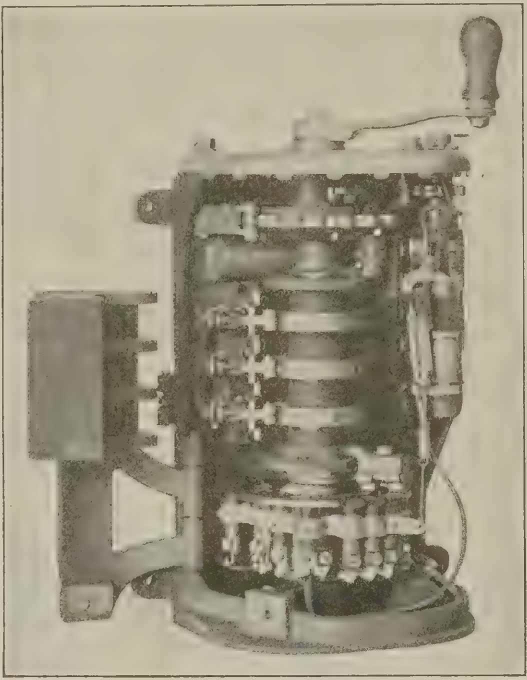

Fig. 2. View of Controller, showing Stationary Contacts and Cylinder Rings.

The General Electric rheostat controller operates in the manner illustrated in the diagram Fig. 3. The parts marked *H*, *I*, *J*, are contact strips mounted upon the surface of a cylinder, the controller being of a design similar to that commonly used on electric cars. The circles, *F*, *C*, and *T*2 are stationary contacts so located that as the cylinder revolves they slide over the strips, or rings, *H*, *I*, *J*. The circles *D*, *A*, *AA*, *R*10, together with the two rectangles on their right, and the four on their left represent an independent reversing switch, the central vertical row of circles being the stationary contacts, and the rectangles on the sides being the movable contacts, these latter being mounted upon the surface of a small cylinder in a manner similar to the rings, *H*, *I*, *J*.

The true position of the contacts, *F*, *C*, *T*2, when the controller is at the off position, is along the vertical line marked *E*; they are drawn at the extreme left so as not to confuse the diagram. An arm, *G*, is electrically connected with ring *H*, and its lower end is arranged so as to slide over a series of stationary contacts, *R*1 to *R*10, connected with the several sections of the rheostat that is introduced in the circuit of the motor armature. When the motor is running, the stationary contacts, *F*, *C*, *T*2, rest upon the rings, *H*, *I*, *J*, along one of the vertical lines 7, 8, 9, or 10, according to the speed required. In stopping the motor, if it is desired to make a normal stop, the cylinder is rotated until the contacts, *F*, *C*, *T*2, reach the line, *E*. If for any reason a quick stop is desired, the cylinder is rotated a little further, until the contacts, *F*, *C*, *T*2, ride over the two small rectangles marked "Brake," in line with rings, *H*, *I*. This movement carries the lower end of *G* over the stationary contact *B* and thus the circuit of the motor armature is closed through the brake resistance. With this connection the armature acts as a generator and generates a current that flows in the local circuit formed through the brake resistance, and the energy required to generate the current soon absorbs the momentum of the armature. The brake resistance is so proportioned as to bring the armature to a state of rest as rapidly as it can without producing a shock. A no-voltage magnet is provided that acts to open the armature circuit whenever the current fails, and another magnet opens the circuit whenever the current becomes too strong. The last named magnet acts by opening the circuit through the coil of the no-voltage magnet, as is clearly shown in the diagram. A push button is included in the no-voltage magnet coil circuit, so that by pressing this the motor may be stopped at any time without returning the controller handle to the off position. The blow-out coil is for the purpose of breaking the sparks formed when the several switch contacts separate. The wires that carry the full armature current are drawn heavy and those traversed by light currents are drawn fine, thus making the diagram more easily traced out.

In starting the motor, the controller cylinder is rotated until the stationary contacts, *F*, *C*, *T*2, rest upon *H*, *I*, *J*, along the vertical line 1, and this brings the lower end of *G* over the rheostat contact *R*1. If we now trace the circuit from the fuse box at the upper right hand corner we will find that the + wire runs to terminal *F*1 of the motor, which is one end of the series field coils, the motor being compound wound. Passing through the series field the current comes out at *F* and flowing through the wire reaches the blow out coil, then the overload coil and thus to controller contact *F*, which is resting on *J*. As *J* and *I* are connected with each other, and *I* is connected with *D* through wire *a*, the current reaches the latter contact. If the reversing switch is turned to the forward position, the current from *D* will pass through the top and third left side contacts to stationary contact *AA* and thus reach the motor armature, passing through the latter to *A* and back to the *A* contact of the reversing switch which is connected with the lower contact *R*10. From this latter contact the current follows the wire *R*10 to the rheostat, and through the latter to contact *R*1, which is connected with *G*. Through *G* the current reaches *H* and thus passes to contact *T*2 and back to the — side of the fuse box. The current for the shunt field of the motor starts from the

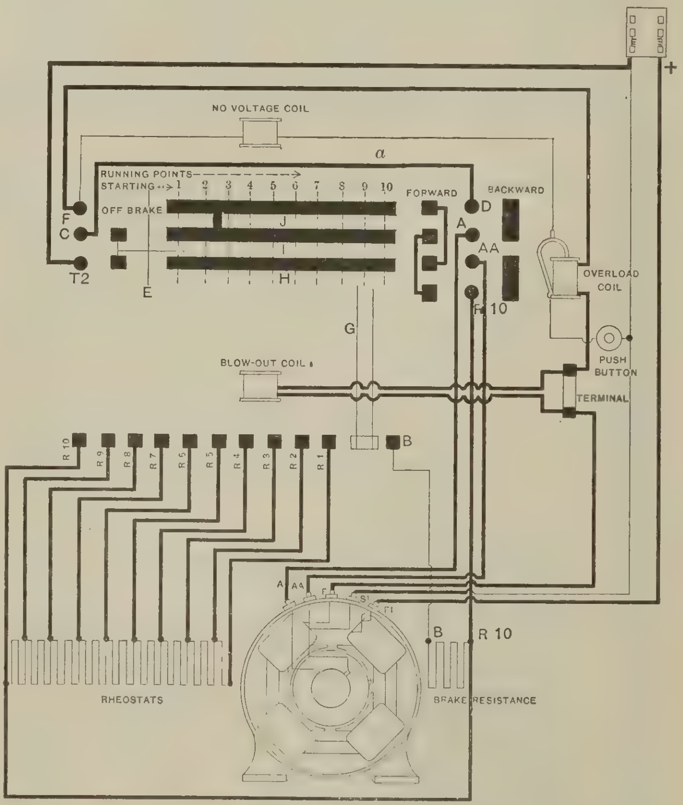

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Fig. 3. Diagram of General Electric Type of Rheostat Controller.

motor terminal $F1$ and comes out at $S1$, which, as will be seen, connects directly with the — side of the fuse box.

The diagram of the controller used by the General Electric Company for field regulation is shown in Fig. 4. This controller, like the one just explained, is provided with no voltage and overload magnets. It also has a reversing switch, and brake contacts for effecting a quick stop. In this diagram the stationary contacts $L+C$ $L-$ are drawn in the proper off position, between the brake contacts and rings, *H*, *I*, *J*. The armature rheostat is used simply to keep the current down in starting, but if it were made of sufficient capacity to carry the working current continuously, it could be used for speed regulation. This modification, however, would produce a controller that would be a combination of the rheostat and the field regulating systems.

The path of the currents in this controller is substantially the same as in the rheostat controller, in fact the only difference is that a field rheostat is added, together with a number of contacts, by means of which its several sections may be cut in or out of the shunt field circuit. For the first four positions of the controller the arm *G* sweeps over the contacts connected with the armature rheostat, all the latter being cut out of the circuit when the fifth position is reached. By tracing the shunt field circuit from the $L+$ wire it will be seen that after passing through the field, the current flows to the line that connects the top row of *R* contacts, so that as long as *G* rests in any of the first five positions there will be no external resistance in the field circuit. When the controller is passed to the sixth position, *G* will rest on the two contacts, $S2$, and $S1$ will be disconnected, so that the current will have to flow through the field rheostat from point $S1$ to point $S2$, and thus reach upper contact, $S2$. From here the circuit will be completed through *G* to *H* and thus through contact $L-$ to the wire leading through the overload coil and the cut-out coil to the $L-$ line wire. By tracing the movement of the controller through the remaining steps it will be seen that at each successive one an additional section of the field rheostat will be cut into the circuit and when the last position is reached all the rheostat will be in circuit, thus giving the weakest motor field.

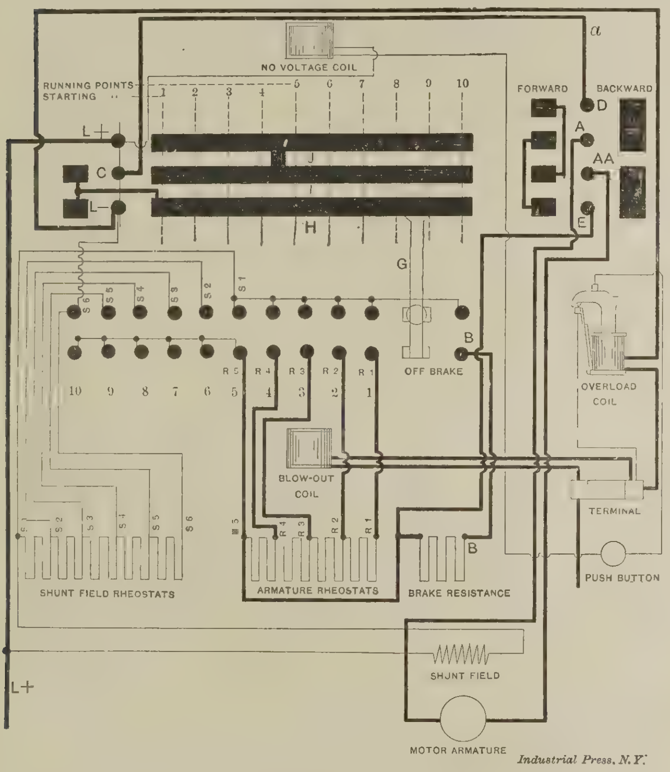

Fig. 4. Type of Controller used for Field Regulation.

The rheostat method of control, as already mentioned, provides means for varying the speed by reducing it below the normal velocity, and the variation may be made as great as desired by simply providing sufficient resistance in the regulating rheostat. With this method, the normal motor velocity must be the highest desired. With the field regulating system, the weakening of the motor field by the introduction of resistance in its circuit, acts to increase the velocity, so that the normal motor speed must be the lowest desired.

The field regulating method of control if used with a motor of standard construction will not effect a very wide variation in speed, owing to the fact that before the field is weakened enough to cause a decided increase in velocity, the sparking at the commutator will become excessive. With the general run of motors it is doubtful if the speed can be increased more than one-third without seriously affecting the sparking. The motors used with field regulation controllers are specially designed for the purpose, and are provided with much larger fields and smaller armatures than the standard type. With such motors it is possible to obtain a speed variation of two to one, without producing any noticeable change in the sparking at the commutator.

From the foregoing it will be seen that the range of seeds obtained with field regulation is very much smaller than with the rheostat method, but as an offset we have far greater efficiency and constant velocity at whatever speed the motor may be run.

The appearance of the controller for field regulation, illustrated in the diagram Fig. 4, is well shown in the photographic prints Figs. 1 and 2, the latter showing the contact shield swung out of position so as to show more clearly the stationary contacts $L+L$ — and *C*, and the cylinder rings, *H*, *I*, *J*. It also shows plainly the arm *G* and the several stationary rheostat contacts over which it sweeps.

* * *

NOTES ON DESIGN.—2.

MACHINERY SHAFTING (concluded).

C. F. BLAKE.

A shaft requiring special investigation in certain classes of machines, as cranes, turntables and other revolving machines, is that effecting the slewing or turning in a horizontal plane. Fig. 7 represents the diagram of a common slewing mechanism for a crane, in which

A = the center pin, column or mast,
B = a large circular rack, concentric with A,
C = a pinion mounted upon a vertical shaft, and meshing with the rack B.
E = a gear, which connects with the slewing shaft,

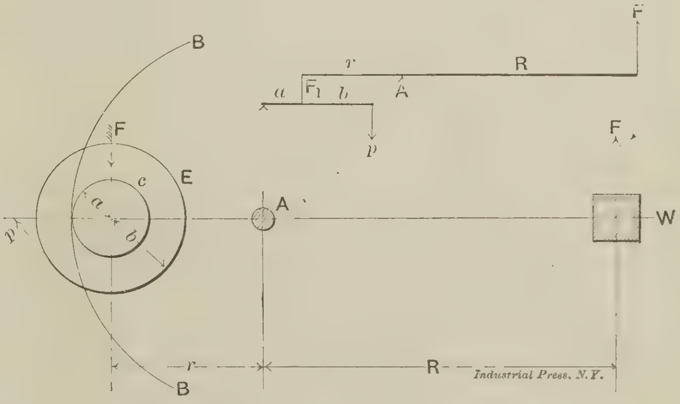

Fig. 7.

W = the load in pounds,
R = the radius of the boom in feet,
r = the radius of the circle of action of the slewing shaft,
a = the radius of the pinion C.
b = the radius of the gear E,
n = the number of revolutions per minute of the crane,

$$V = \text{the velocity of the load } W \text{ in feet per second} = \frac{2\pi R n}{60}$$

$$V^2 = 0.01\,R^2 n^2$$

S = space in feet in which full velocity is to be obtained,
F = force in pounds acquired by the load W,
F_2 = force in pounds on the slewing shaft,
p = force in pounds on the pitch line of gear E,
g = acceleration, = 32.2,

$$\text{Energy} = \frac{W\,V^2}{2\,g} = F\,S$$

Then,

$$F = \frac{W\,V^2}{2\,g\,S} = \frac{W\,V^2}{6.44\,S} \ldots\ldots\ldots\ldots(2)$$

Assuming S = one-quarter of a turn, $= \frac{2\,\pi\,R}{4} = 1.57\,R$, and substituting the values of S and V^2 in (2) we have,

$$F = 0.001\,R\,W\,n^2$$

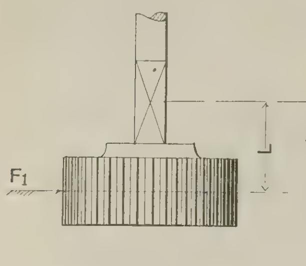

Fig. 8.

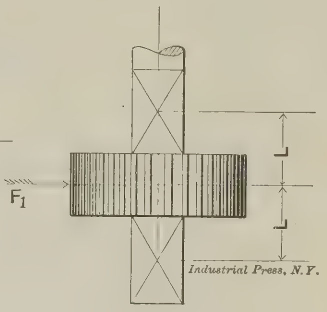

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Fig. 9.

Now

$$F_1 = \frac{F\,R}{r} = \frac{0.001\,R^2\,W\,n^2}{r},$$

also

$$p = \frac{F_1\,a}{a + b}$$

and the twisting moment on the shaft is,

$$p\,b = \frac{F_1\,a\,b}{a + b} \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Substituting in (3) the value of F_1, assuming f = 10,000 pounds per square inch, and equating to the moment of resistance of the shaft to torsion, we have,

$$\frac{\pi}{16}\,d^3\,f = \frac{0.001\,R^2\,W\,n^2}{r}$$

$$d^3 = 0.000{,}000{,}5\;\frac{n^2\,R^2}{r}\;\frac{W\,a\,b}{a + b}$$

$$d = \sqrt[3]{h\,\frac{W\,a\,b}{a + b}} \ldots\ldots\ldots\ldots\ldots(4)$$

Table 4 gives values of h for various values of the ratio $\frac{R^2}{r}$ and n.

The pinion C may be either overhung, or mounted between bearings, as shown respectively in Fig. 8 and Fig. 9. The values of k are as follows:

Overhung Shaft, Fig. 8.

$$M = F_1\,L = \frac{.001\,R^2\,W\,n^2\,L}{r}$$

Substituting value of F_1 in (3) we have

$$p\,b = T = \frac{.001\,R^2\,W\,n^2\,a\,b}{r\,(a + b)}$$

and

$$k = \frac{M}{T} = \frac{L\,(a + b)}{a\,b}$$

Shaft between Bearings, Fig. 9.

$$M = \frac{F_1\,L}{2} = \frac{.001\,R^2\,W\,n^2\,a\,b}{2\,r}$$

Substituting value of F_1 in (3) we have

$$p\,b = T = \frac{.001\,R^2\,W\,n^2\,a\,b}{r\,(a + b)}$$

and

$$k = \frac{M}{T} = \frac{L\,(a + b)}{2\,a\,b}$$

In taking the values of W and R, not only the load and the radius of the boom must be considered, but also the weight and radius of such heavy parts of the machinery as may revolve with the crane, in each case resolving the turning moment of such parts about the center pin or mast, to the radius R.

Example: Fig. 10 represents a steam crane, the letters corresponding to those of Fig. 7, while the dimensions and weights given are those of a particular crane having a capacity of ten tons at a radius of sixteen feet, the pinion C meshing into an internal spur rack in the foundation and being driven by bevel gears as shown. Required the diameter of the vertical shaft, f being 12,000 pounds per square inch.

$\frac{R^2}{r}$	Values of n.					$\frac{R^2}{r}$	Values of n.				
	1	2	3	4	5		1	2	3	4	5
20	.00001	.00004	.00009	.00016	.00025	120	.00006	.00024	.00054	.00097	.0015
30	.000015	.00006	.000135	.00024	.000375	122	.000061	.000244	.000549	.000986	.001525
40	.00002	.00008	.00018	.00032	.0005	124	.000062	.000248	.000558	.001002	.00155
50	.000025	.0001	.000225	.0004	.000625	126	.000063	.000252	.000567	.001018	.001575
60	.00003	.00012	.00027	.00048	.00075	128	.000064	.000256	.000576	.001034	.00160
70	.000035	.00014	.000315	.00056	.000875	130	.000065	.00026	.000585	.00105	.001625
80	.00004	.00016	.00036	.00064	.001	140	.000070	.00028	.00063	.00113	.00175
90	.000045	.00018	.000405	.00073	.000112	150	.000075	.0003	.000675	.00121	.001875
100	.00005	.0002	.00045	.00082	.00125	160	.000080	.00032	.00072	.00129	.00200
110	.00055	.00022	.000495	.0009	.001375	170	.000085	.00034	.000765	.00137	.002125

For f = 12,000 multiply by .833
For f = 16,000 multiply by .625

Table IV. Values of h for Various Values of $\frac{R^2}{r}$ and n.

The load at 16 feet — 0 inches radius = ...20,000 pounds.

The block at 16 feet — 0 inches radius = ... 435 "

The jib weighs 3,000 pounds, its center of gravity being at a radius of 11½ feet, resolved to a radius of 16 feet — 0 inches = $\frac{3{,}000 \times 11.5}{16}$ = ... 2,156 "

The boiler and extension weigh 11,855 pounds at a center of gravity radius of 8½ feet, resolved to a radius of 16 feet — 0 inches $= \frac{11{,}855 \times 8.5}{16}$ = ... 6,297 "

The machinery and side frames weigh 21,800 pounds, at a radius of 2 feet, resolved to a radius of 16 feet — 0 inches $= \frac{21{,}800 \times 2}{16}$ = 2,725 "

Total load assumed at a radius of 16 feet — 0 inches =..........................31,613 pounds.

$$\frac{R^2}{r} = \frac{16^2}{2} = 128$$

Opposite 128 and under n = 3 in the above table, 3 being the required revolutions per minute of the crane in question, the value of h is 0.000576, and since the shaft is to be strained to 12,000 pounds per square inch we have,

$h = 0.000576 \times .833 = 0.00048.$

From (4) we have

$$d = 0.00048 \frac{31{,}613 \times 5 \times 9}{14} = 3.65 \text{ inches diameter for}$$

twisting only.

The pinion being mounted between bearings, we have $L = 6$ inches, and

$$k = \frac{6\,(5 + 9)}{2 \times 5 \times 9} = 0.93$$

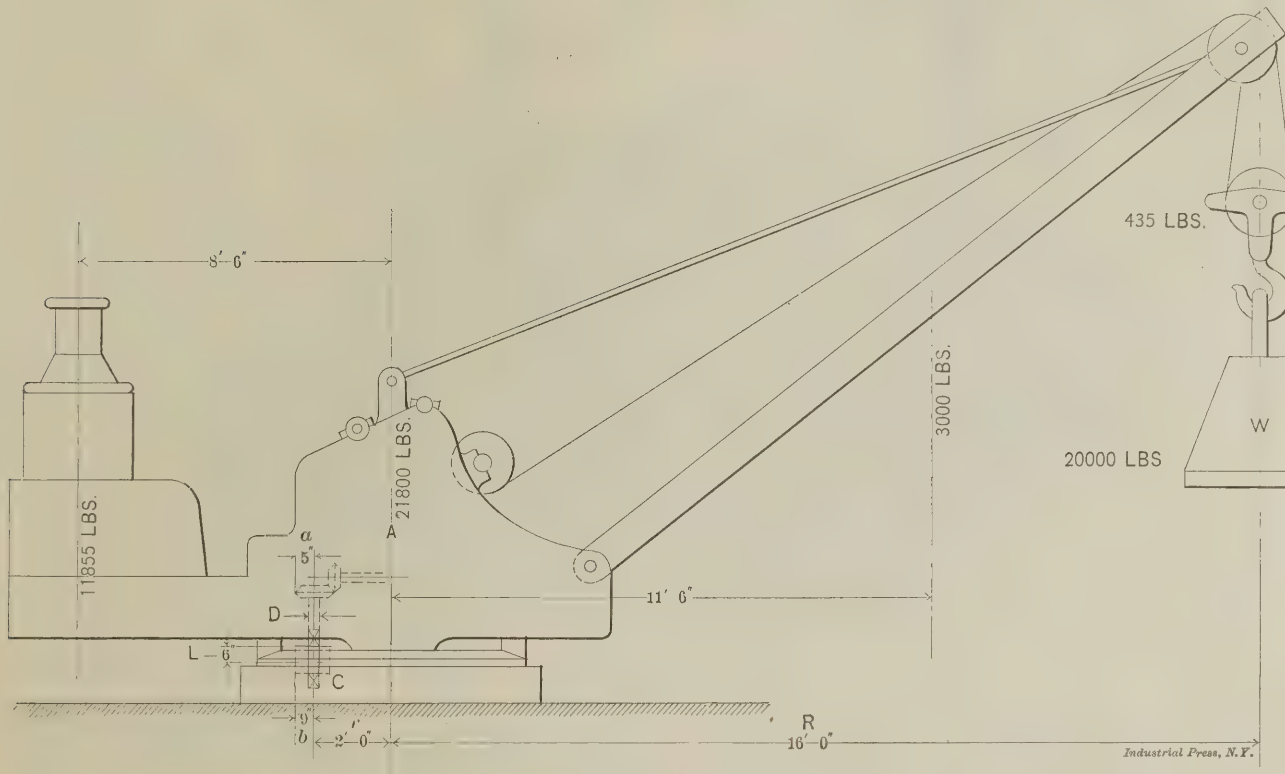


Fig. 10.

Corresponding to this value of k we find $N = 1.3$ in Table 3 in the last article. Then

$d = 3.65 \times 1.3 = 4.64$ inches diameter shaft required.

When calculating the size of shafting, the first thing of importance to determine is the length of the journal, and once established, all bending moments should be taken to the center of the journal. Given the diameter, the length of the journal depends upon three conditions: Bearing area, character of lubricant, and ability to carry off heat. Grease has become a most widely used lubricant for heavy machinery, possessing as it does sufficient body to enable the designer to use higher bearing values than with other lubricants without squeezing the lubricant from the bearing. It has been found in practice that to limit the surface speed to 350 feet per minute, and the bearing value to 80 pounds per square inch of projected area, produces, with grease as a lubricant, a very satisfactory bearing, well within the limits of good performance as regards heating.

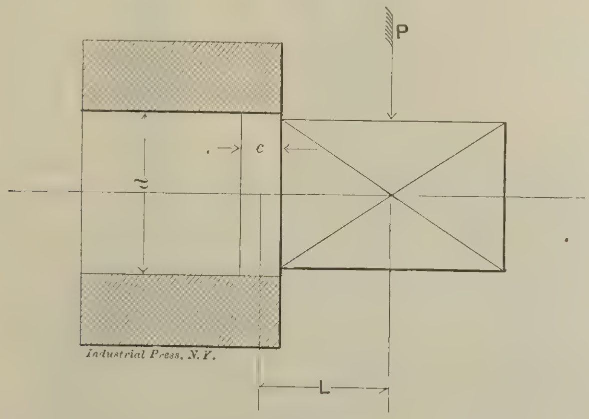


Fig. 11.

Let $d =$ the diameter of the shaft,

$l =$ the length of the journal.

$a =$ the projected area, $= d \times l$,

$W =$ total pounds pressure on journal.

$R.P.M. =$ revolutions per minute of the shaft.

Then the pressure per square inch is,

$$\frac{W}{a} = \frac{W}{d \times l} = 80 \text{ pounds}$$

$$d = \frac{W}{80\,l}$$

The surface speed is,

$$\frac{\pi\, d \times \text{R. P. M.}}{12} = 350$$

$$d = \frac{12 \times 350}{\pi \times \text{R. P. M.}} = \frac{1337}{\text{R. P. M.}}$$

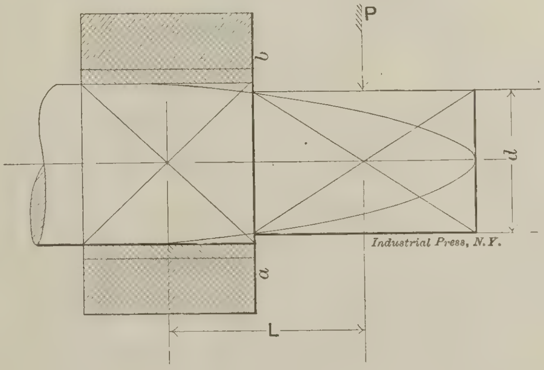


Fig. 12.

Equating these two values of d we have,

$$\frac{W}{80\,l} = \frac{1337}{\text{R. P. M.}}$$

$$l = \frac{W \times \text{R. P. M.}}{106{,}960}$$

and rounding off the constant to a more convenient figure, we have

$$l = \frac{W \times \text{R. P. M.}}{100{,}000}$$

Cases will arise, especially with heavily loaded slow running shafts, in which this rule gives a bearing altogether too short for practice, sometimes not allowing room for the stud bosses on the cap, and also having too high a bearing value, which should be kept below 1,000 pounds per square inch. For shafts running about 80 R.P.M. or faster, the above rule gives excellent bearings, while for slower running shafts an investigation of the bearing value as well as the above rule at once determines the limiting length of the journal.

Chart No. 1 will be found of great convenience in determining the dimensions of journals.

The example shown by the heavy line in the upper portion of the chart, shows that a journal under 650 pounds total pressure, and running 1,250 R.P.M. should be eight inches long. This at once determines the length of the journal and leaves the diameter to be determined by calculating the bending moments to the center of the journal.

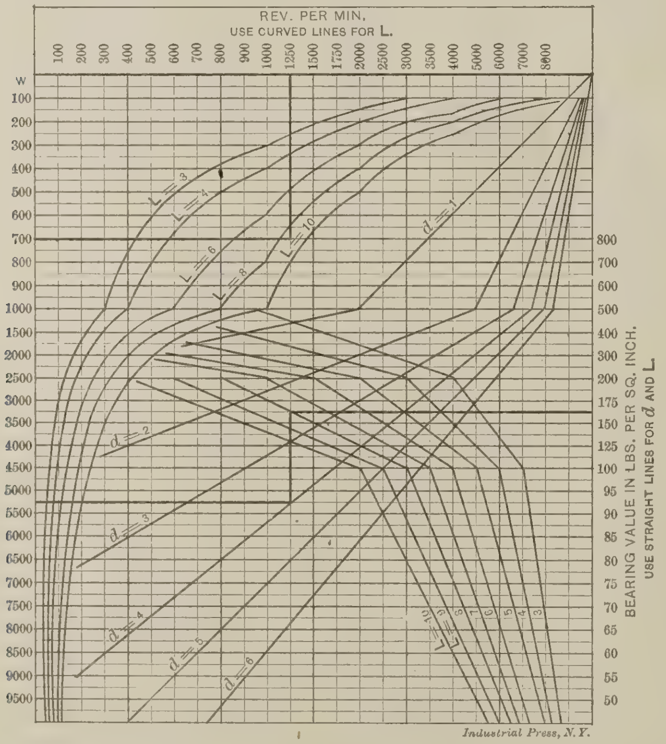
The example given in the lower part of the chart shows that a journal 4 inches in diameter and 8 inches long under 5.250 pounds total pressure, will have a bearing value of 162 pounds per square inch of projected area.

A condition frequently met with is that of a shaft forced by pressure into one member, and revolving in another member, as in Fig. 11.

The arm L is determined by laying off a distance c such that

$$\frac{P}{c \times d} \mathrel{\overset{=}{<}} \text{the safe crushing strength of the metal composing the supporting member.}$$

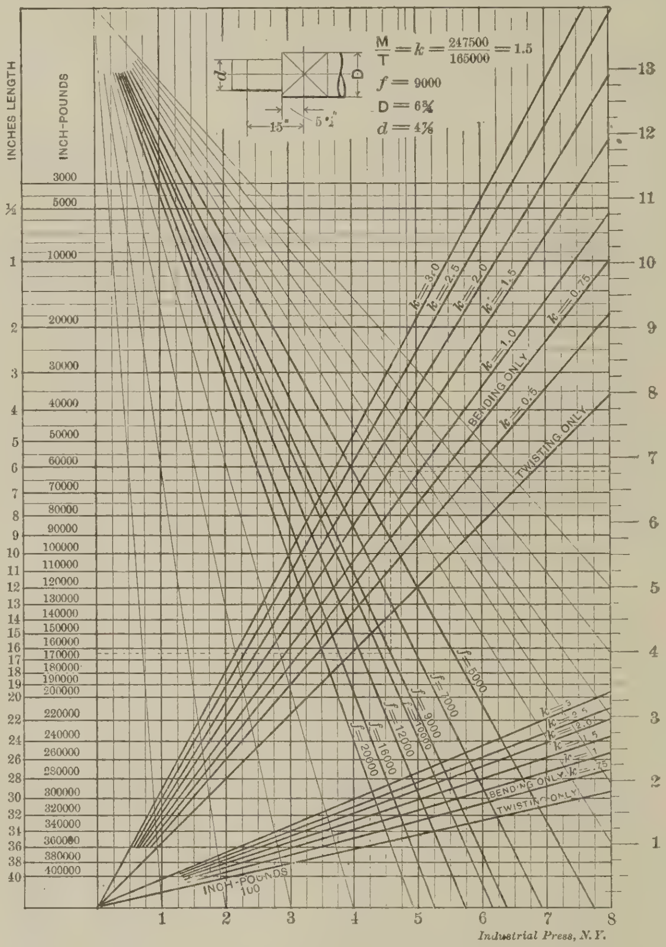
and taking L as the distance from the load P to the center of the strip c. It is excellent practice to provide slight shoulders wherever practicable, against which to key the gears, thus locating gears definitely for the assembling workman. Frequently a heavily loaded pinion demands a smaller shaft than the foregoing rules require, in order to leave sufficient metal over the key. This may be accomplished by making the diameter d at the section a — b, Fig. 12, coincident with the diameter of a parabola drawn from base D.



Industrial Press, N.Y.

Chart I.

A most convenient solution of this problem is offered in Chart No. 2, which also solves at a glance all problems regarding shaft diameters to withstand any combination of moments. The shaft shown at the top is worked out in the chart by following the dotted lines. The shaft is subject to a bending moment of 247,500 inch-pounds, and a twisting moment of 165,000 inch-pounds, hence $k = 1.5$, also $f = 9{,}000$. Enter the chart at the left at 165,000 inch-pounds and follow dotted line to the $f = 9{,}000$ line, thence up to the $k = 1.5$ line, thence over to the right, and read diameter of required shaft on the scale, 6¾ inches. It is now required to find the smallest permissible diameter for the end of the shaft according to the dimensions given. Follow the line marked 15 in the extreme left-hand column to first intersection with the line for 6¾ inches from the scale at the bottom of the chart, thence diagonally to the line marked 5½ at the extreme left, thence up, and read the required diameter on the scale at the top, 4⅞ inches.



Industrial Press, N.Y.

Chart II.

For shafts subjected to simple bending or simple twisting moments use the lines so marked instead of the k lines. The set of lines marked $\frac{\text{inch-pounds}}{100}$ are to be used for smaller shafts by dividing all readings in the column of inch-pounds by 100. This makes the range of the chart from 30 to 400,000 inch-pounds.

* * *

AN ELECTRICAL METHOD OF STRAIGHTENING WIRE.

Amongst the various ingenious temporary expedients which the writer has seen employed in electrical works he calls to mind a method of straightening badly kinked wire which is probably unique. Some old armature wire had been thrown on one side as only fit for the scrap-bin, but it happened to be just the gage required for a particular purpose in the test-room. The following method was therefore adopted to straighten it: One end was attached to a wooden bench and the other fastened to a stout piece of wood which was held by an assistant. A large current was then sent momentarily through the wire from a set of accumulators and at the same moment the assistant gave it a good sharp pull, the result being a beautifully straight piece of wire. It was no doubt reduced in diameter, but so slightly as to be practically immeasurable.—*Page's Magazine.*

* * *

Ignorance sometimes brings bliss, but more often it brings blisters.—*Ryerson's Monthly.*

A MASSIVE GEAR PLANER.

The machine shown herewith was built by the Gleason Works, Rochester, N. Y., for the Cambria Steel Co., of Johnstown, Pa., and is the design of Mr. Wm. Gleason. As shown in the end elevation, Fig. 1, the mandrel which carries the work, revolves over a pit. The gear to be cut, revolving with the work mandrel, may extend below the level of the base of the machine. The actual capacity of the machine might be said to be much larger than 20 feet diameter. In fact the diameter capacity would be only limited by the amount of error that could be allowed in the dividing of the teeth. On actual test the indexing mechanism divided the teeth on a 15-foot gear within a limit of .0015, which is much finer than actual practice requires. The dividing wheel is 9 feet in diameter and the indexing is done by power. A wheel 30 feet in diameter can be cut by making the pit under the machine deep enough and moving the work carrying spindle over to its extreme position.

The rear view of the machine, Fig. 2, shows the rectangular hole in which the bar operates, that draws the tool slide. It will be noticed that this bar has been placed as nearly directly in line with the cutting point of the tool as practicable, the object being to produce a powerful steady motion for the cutting tool.

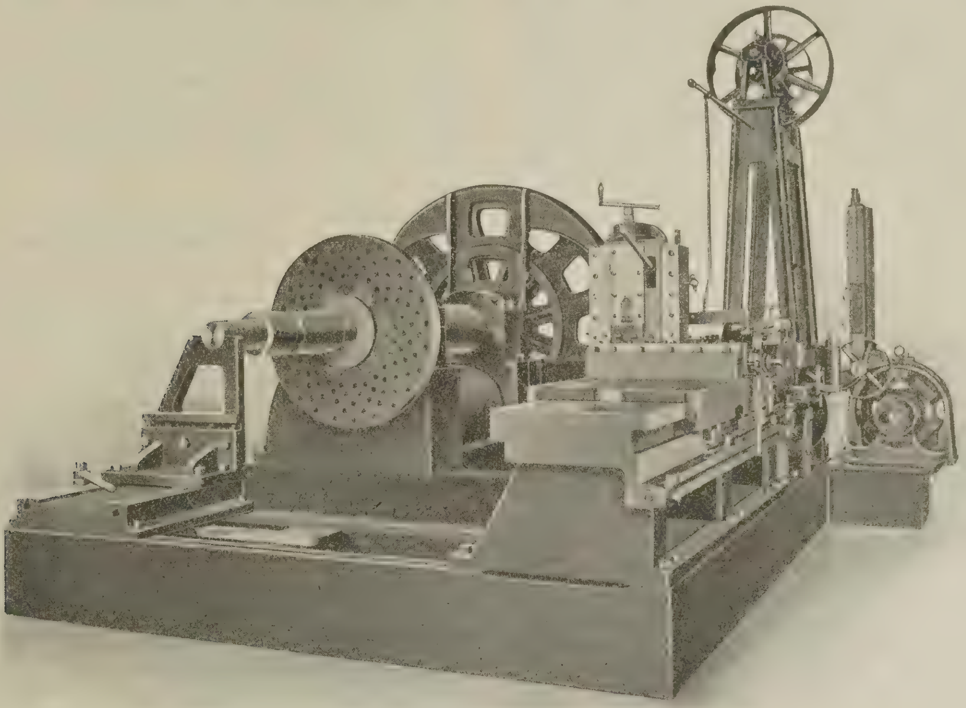


Fig. 1. Large Spur Gear Planer.

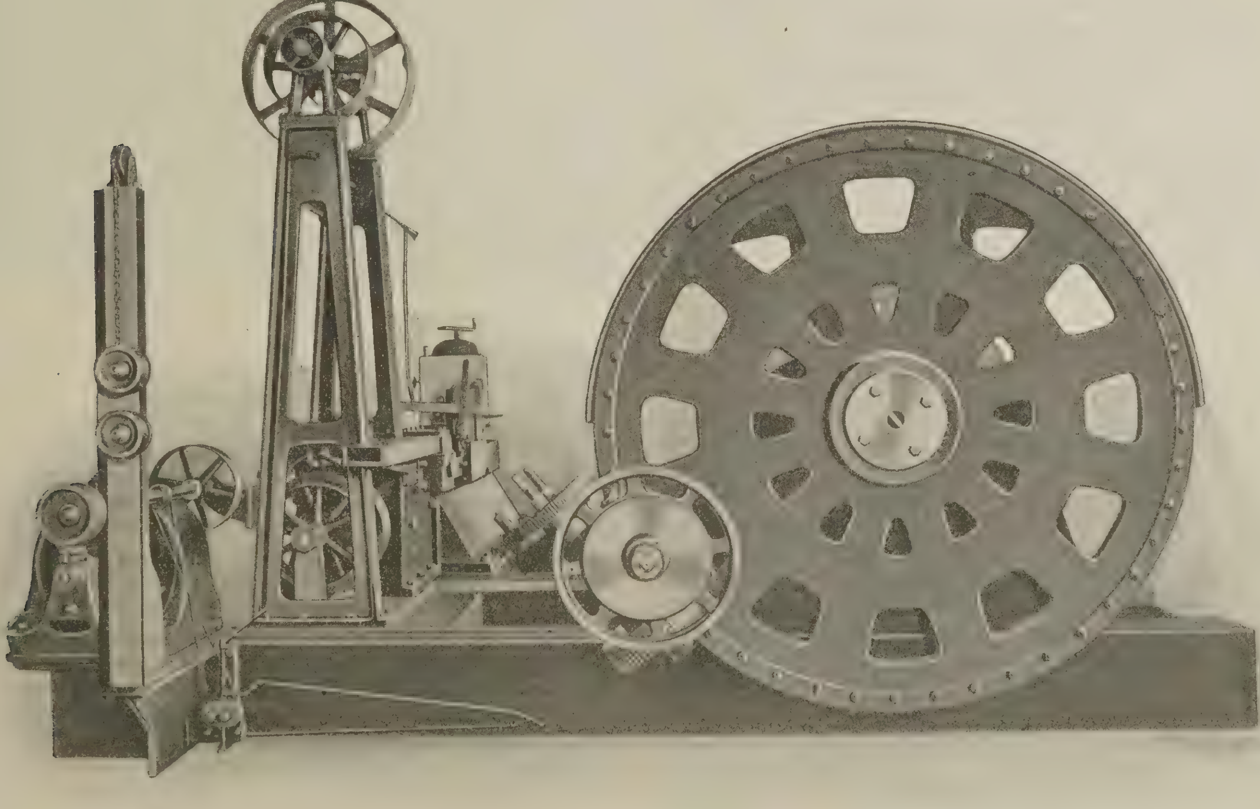


Fig. 2. Gear Planer for Gears up to 30-feet Diameter and 12-inch Pitch.

The power is obtained from a 15-horsepower motor which drives a countershaft placed on top of the standards, as shown in both views, and from the countershaft to the shaft directly below it. The connection is by means of the familiar open and crossed belts with shipper motion, as used on iron planers.

The large steel gear castings for the cutting of which this gear planer was designed have very rough surfaces on the teeth as they come to the machine. For this reason it is necessary to rough-cast the teeth in order to save metal and insure good castings. Some of the gears to be cut are 12 inches circular pitch. Sand spots and hard scale are very hard on the cutting tools, and planer tools, guided by a former, have been adapted to do this work. The roughing tools are not expensive to keep in order and they cut under the scale and rough surface. These tools can be operated at high speeds and coarse feeds when roughing out.

A forming tool is used to remove the tool marks left by the single-pointed roughing tools, except in the case of the very coarse pitch gears, such as the 12-inch circular pitch, in which case the surface of the teeth have to be finished entirely by the single-pointed tools guided by formers. It has been found necessary to finish these coarse pitches with the single-pointed tool because the large amount of surface to be covered makes it better practice to break up the cut in order to reduce the thrust on the cutting tools.

With the machine was furnished a 20-degree involute interchangeable set of spur gear formers, by which gears can be planed ranging from 10 inches diameter to the full capacity of the machine. Each former is stamped for the pitch diameter on which it is made. A pair of formers, one for the top and one for the bottom side of the tooth, will plane gears from the smallest pitch up to a pitch using the full length of the curve. A pair marked for 30 inches diameter would cut any gear 30 inches diameter, 4 diametral pitch to 6 inches circular pitch exactly right.

The gear blank is supported by a thrust brace at the rim, to resist the thrust of the cut; and the pressure of the brace is released each time the gear is indexed, and again applied after the gear has come to a stop and before the tool starts to cut.

The weight of this machine is 80,000 pounds.

* * *

EARLY AUTOMOBILING.

Mr. Oberlin Smith, president of the Ferracute Machine Co., tells of an early experience in automobiling in a recent number of the *Electrical World and Engineer.* Upon a certain occasion over forty years ago he entered into an "autoing" collaboration with another boy, who is now a distinguished professor of mathematics, both being fired with enthusiasm to emulate the recorded performances of the occasional steam carriages appearing in England from Sir Isaac Newton's time into and through the eighteenth century.

Instead of building such a vehicle entire, the boys procured a farm engine of about 5 horse power built in the general style of a steam fire engine, that is, with a vertical boiler at the rear, fired from behind, and a horizontal engine lying upon the framework in front. They soon realized the difficulty of steering by swinging the front axle with sufficient power and delicacy should either wheel strike an obstruction. This they overcame somewhat ingeniously by fastening ropes near each end of the axle, which came upward and rearward to the main shaft of the engine, being wrapped loosely two or three times around the same, on the principle of a "snubbing post." These ropes continued upward to the hands of the steersman, and with them he could control the axle perfectly by tightening one or the other more or less, the power to hold it against obstacles at either wheel being, of course, supplied by the engine as a rope tightened upon and grasped the shaft thereof.

Upon the first trial one of the rear wheels was connected with the engine by a wide belt running from a small pulley on the end of its shaft to a very large one bolted to the spokes of the wheel, which thus served as the only "driver." In their haste to get the machine under way they waited not for good weather, but started upon a rainy day with the ground covered with slush. The belt soon got wet and the "auto" was held up for repairs.

For the next trial a chain and sprockets (not easily procurable in those days) were substituted for belt and pulleys. The machine itself ran well in spite of having only one driver, but, time still being precious in the eyes of the adventurers, the next start was made over a very bad road covered with snow two or three inches deep. This road was narrow and crooked, soon reaching a narrow wooden bridge spanning an icy river, then running up a hill at a moderate grade. To avoid delay, no connection was made at this first trial from the throttle valve (an ordinary 1¼-inch steam cock) at the rear of the boiler to the driver's seat in front, where he might have attended to it had not both hands been busy with the steering ropes, and both feet with bracing himself to keep him in his seat.

The professor was kindly allowed the honor of the first trial and when duly mounted yelled to the small boy who acted as fireman (standing upon the ground) to turn on steam, which then stood at high pressure. Being both obedient and strenuous, this youngster revolved the cock handle suddenly through an arc of some 90 deg., then letting it slip off and fall hidden in the snow as the machine bounded forward and left him standing in amazement at the ambition thereof.

Young Smith, who was acting as general traffic manager, rushed into the shop wildly searching for a monkey-wrench and triumphantly emerged in chase of the lost auto car, which the powerless chauffeur had by that time succeeded in steering at full speed around the turns of the road and between the railings of the bridge—rather than down a steep bank into the river below. As he reached the hill beyond, with the car ascending and the steam pressure descending, the monkey-wrench and the boy he left behind him succeeded in reaching the steam-cock, and everything ended happily. The machine not afterward proving comfortable enough for a touring car was classed in the grade of runabouts, in view of the performances it had given. Later on it became a stayabout.

In contrast, Mr. Smith says of future automobiling: "To bring about halcyon days of pleasure travel, two important new conditions are necessary. The first is to have a cheap, light and durable storage battery. The second will consist in the establishment of a system of electric charging stations upon our streets, roads and waterways. The improvement of the storage battery will vitally affect the running of automobiles and pleasure boats which are now run by their owners and chauffeurs under conditions of martyrdom."

* * *

COMPRESSED AIR EXPLOSIONS.

It is a pretty well-established fact that a compressed-air system, *i. e.*, the compressor, receiver and pipes, has within itself the potentiality of destructive explosion if the matter of air-cylinder lubrication is indifferently attended to. That is, if lubricating oil of low flash-point is fed into the air cylinder of a single-stage compressor working against a pressure of say 80 pounds per square inch or more, the practice is fraught with danger, but there is an element of mystery in some of these explosions that has not been made exactly clear. Theoretically it can be shown that if low flash-point lubricating oil is fed into a compressed-air system it may readily form an explosive gas, and the heat generated in compression under certain conditions might suffice to fire the charge. But such explosions are rare, although the conditions found in many cases seem to invite such a disaster. In a paper read by Mr. R. Jordan before the South Wales Institute of Engineers a compressed-air system explosion was described in which the air cylinders were lubricated with a mixture of soft soap and water—2 pounds of soap to 1 gallon of water—and the hinge bars of the valves with "Valvoline" oil. About two gallons of the soap mixture and two quarts of the oil were used in twenty-four hours. The air cylinders of the compressor were 26 inches diameter and 42 inches stroke and the air pressure was about 60 pounds. The damage done in this case was not serious; the system was in a colliery and no one was hurt. The explosion is attributed to no particular condition, but certain causes were laid down that might have contributed to the wreck. Coal dust drawn in with the free air combines with the oil and soap suds and forms a solid deposit which when heated gives off an explosive vapor. It has been shown that coal dust alone will ignite at a temperature of 291 degrees F., and in the vicinity of a colliery it is conceivable that if the intake pipe was carelessly located there might be sufficient accumulation of dust to become explosive in the receiver. The temperature of compression is not ordinarily high enough to fire a charge, but if the piston is allowed to run dry or if the discharge valves or pipes become choked with accumulations the temperature of air discharged from the cylinder might easily pass the danger point. The frequent removal of all solid and liquid deposits from air-compressors is advocated, especially where carbonaceous dust is taken in with the free air. Obviously the intake should be located where the air will be pure and cold as possible.

* * *

THE R. K. LE BLOND MACHINE TOOL COMPANY'S SHOP.

In previous issues we have referred to the growth of the machine tool industry in Cincinnati, Ohio, a city which now occupies the leading place in the United States in the manufacture of lathes, planers, milling machines, shapers, drills and other machines for working metals—to say nothing of the great factories engaged in the manufacture of woodworking tools. As also previously mentioned, most of the newer shops are located in the Mill Creek valley district, and in the September, 1902, issue a map of this section was published showing the location of the various shops embraced by it. The large shop of The R. K. LeBlond Machine Tool Co., however, is located on the opposite side of the city, on Eastern Avenue, and the location and shipping facilities appear to be equal to those of the more favored district.

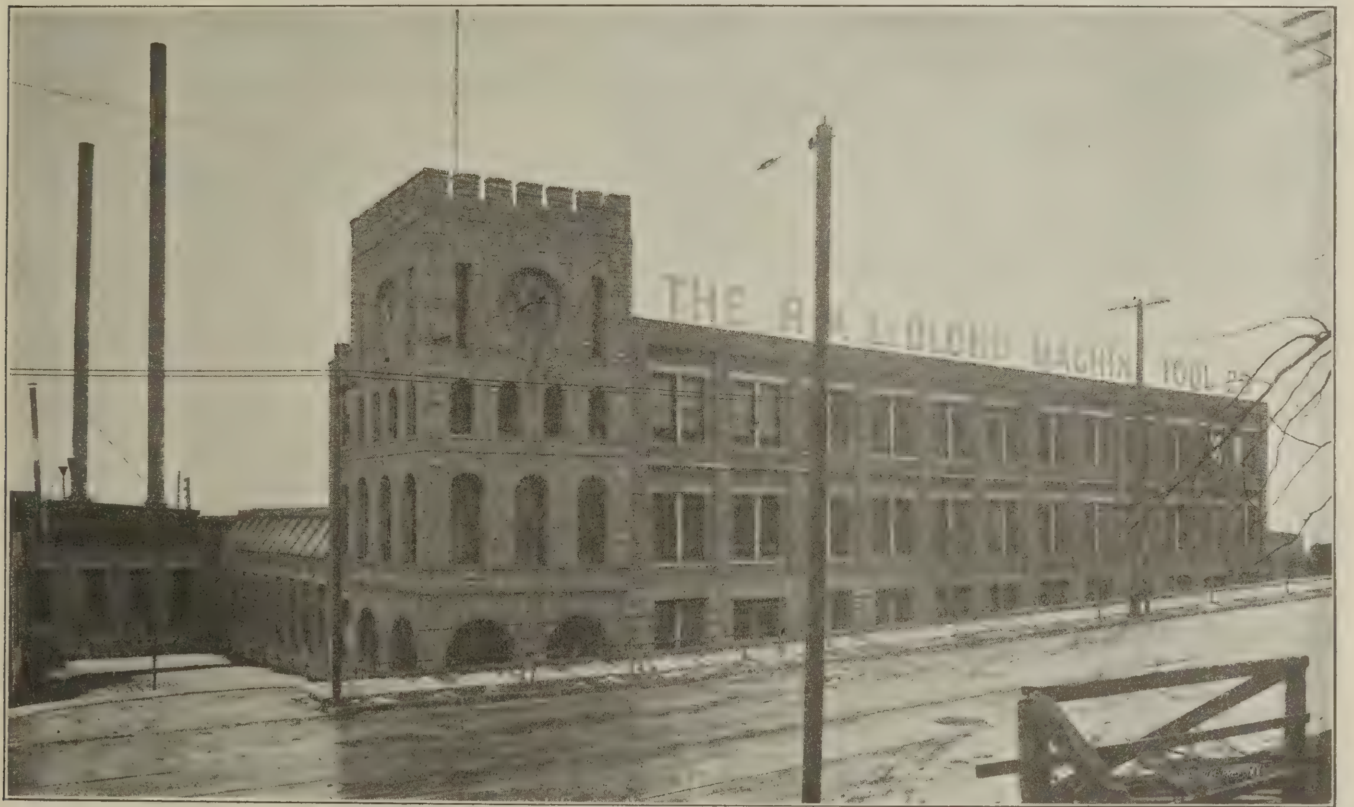


Fig. 1. General View of The R. K. Le Blond Machine Tool Company's Shop.

This shop was built about five years ago, and is quite unique in its general plan and arrangement. The general view, Fig. 1, shows the three-story front section and tower; at the far end of the three-story front section a three-story wing extends at right angles, forming an "L." The "L" is indicated in the plan, Fig. 2, by the full and dotted lines, *A*, *B*, *C*, *D*, *E*, *F*. The remainder of the plan is one story high, with basement under part of it, which is utilized for storage purposes. Extending to the north is the one-story engine room, boiler room and blacksmith shop. This and the side of the one-story machine shop section may be seen in Fig. 1, at the left. The roof of this latter section is of the saw-tooth variety, having four sections or gables, and general interior views of it may be seen in Figs. 8, 9 and 10. In the plan, Fig. 2, a pier is indicated by the dotted lines, *G*, *H*, *J*, *K*, upon which are located the planers. This pier, of course, is built up level with the shop floor, and is surrounded by masonry retaining walls. The earth within the walls was tamped down solidly and the top was finished off with a layer of concrete. The planers are thus given a solid foundation entirely independent of the shop structure or foundation walls. The basement on the east and west sides of the pier is used as storage spaces for patterns, castings, etc. The basement space adjacent to the pier on the east is utilized for the storage of steel bar stock, and power hack-saws are set up there for cutting the stock into lengths as required. Beyond this section is the basement of the three-story wing section which is used as a washroom and storage for bicycles. This room is very comfortably fitted up with sanitary conveniences and each man has an individual locker bearing a number which is his check and payroll number. The floor is concrete.

The boiler house also shelters the blacksmith shop. This is equipped with casehardening furnaces, steam hammer, etc. The engine room adjacent contains the main engine connected to the lineshaft by belt, and a direct-connected engine and electric generator. The method of transmitting power from the main lineshaft to the parallel lineshafts is indicated in the plan, Fig. 2, and illustrated in Fig. 13. On each side of the main pulley are located narrow face pulleys for transmitting motion to the next lineshaft. In this way the pull on the main lineshaft is partially balanced, and by having a pulley on each side of the main pulley the balancing tendency is equalized on each side of the main pulley.

The lineshafts run on Hyatt roller bearings and throughout the five years of use they have given good satisfaction. As shown in Fig. 13 the hangers are made so that they may be readily adjusted vertically, being clamped to pipe sections which in turn are secured to the roof. Tension rods secure them laterally, and these are adjustable so that any box requiring change of location can be moved up or down, or sideways, or both, as may be necessary.

The main entrance is in the base of the stone tower and is partially hidden in the general view, Fig. 1, by the street

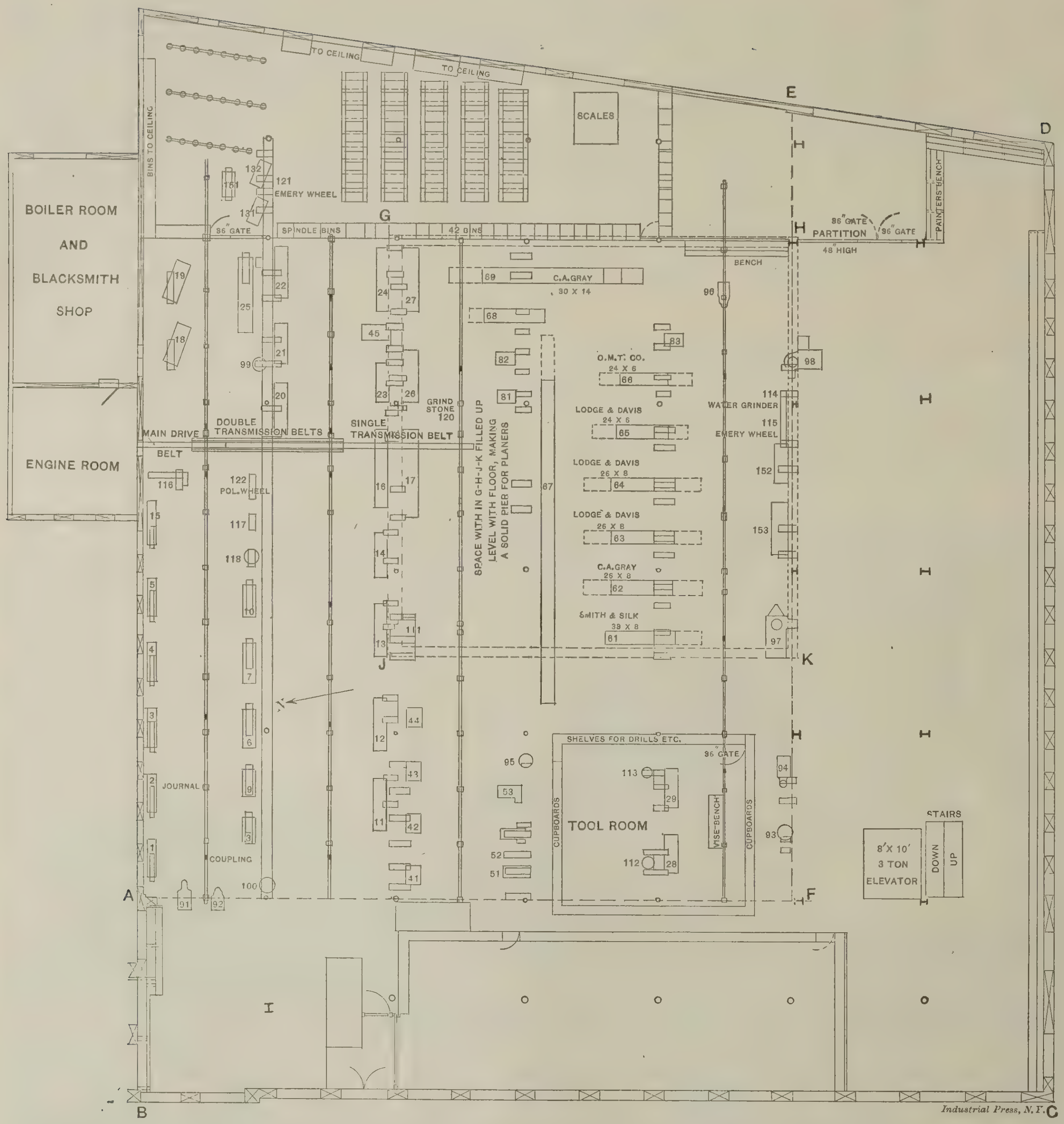


Fig. 2. Plan of Shop, R. K. Le Blond Machine Tool Company. Scale: 1 inch = 23 feet nearly.

grade, which was raised several feet after the shop was built and which accounts for the apparently low position of the building. The general offices are on the second floor of the tower section and the private dining room for the officials of the company is on the third floor of the tower. A view of the private dining room is shown in Fig. 16. The top floor of the tower is occupied by a Seth Thomas clock with striking attachment.

The drafting room is on the second floor, about midway of the front section, and is partly shown in Fig. 4. All drawings are made in pencil on bond paper and inked in. The sizes used are 12 x 18 inches, 18 x 24 inches, and 24 x 36 inches. When inking in a drawing the practice is to spread an old blueprint on the board beneath the paper, which relieves the glare from the bond paper. The blueprints are printed from these drawings in the usual manner and practically as good results are obtained as with tracings on cloth. Blueprints for the shop are mounted on heavy strawboard and shellacked over. When a blueprint becomes dirty or damaged it is destroyed, together with the strawboard back. When a workman gets a blueprint he gives a check and the number of the drawing is written with pencil on the back of the check, which is hung on the hook from which the blueprint was taken. In this way the location of a blueprint can be discovered by an inspection of the check. When a blueprint becomes obsolete it is marked "Discarded," together with the date, and is filed in special drawer reserved for the purpose and the original drawing is also taken from the file and

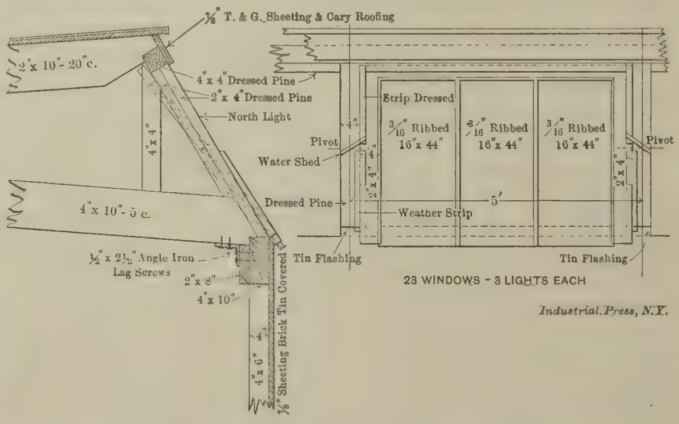


Fig. 3. Details of Windows, 40 foot Section.

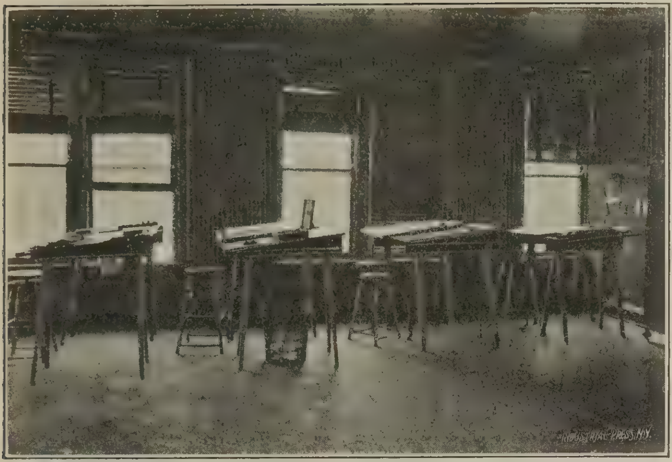


Fig. 4. Drafting Room.

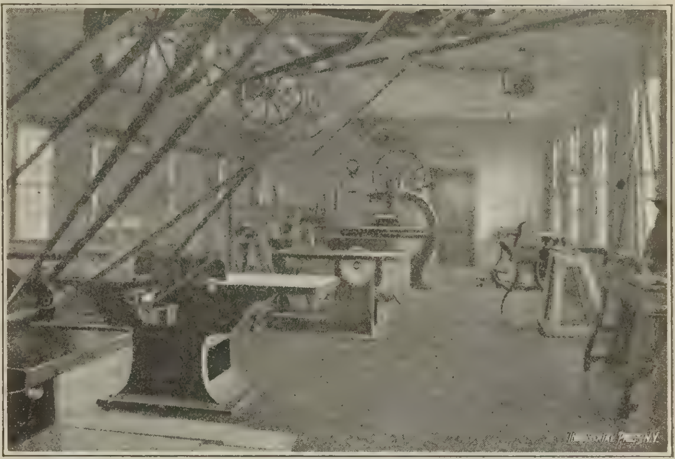


Fig. 5. Pattern Shop.

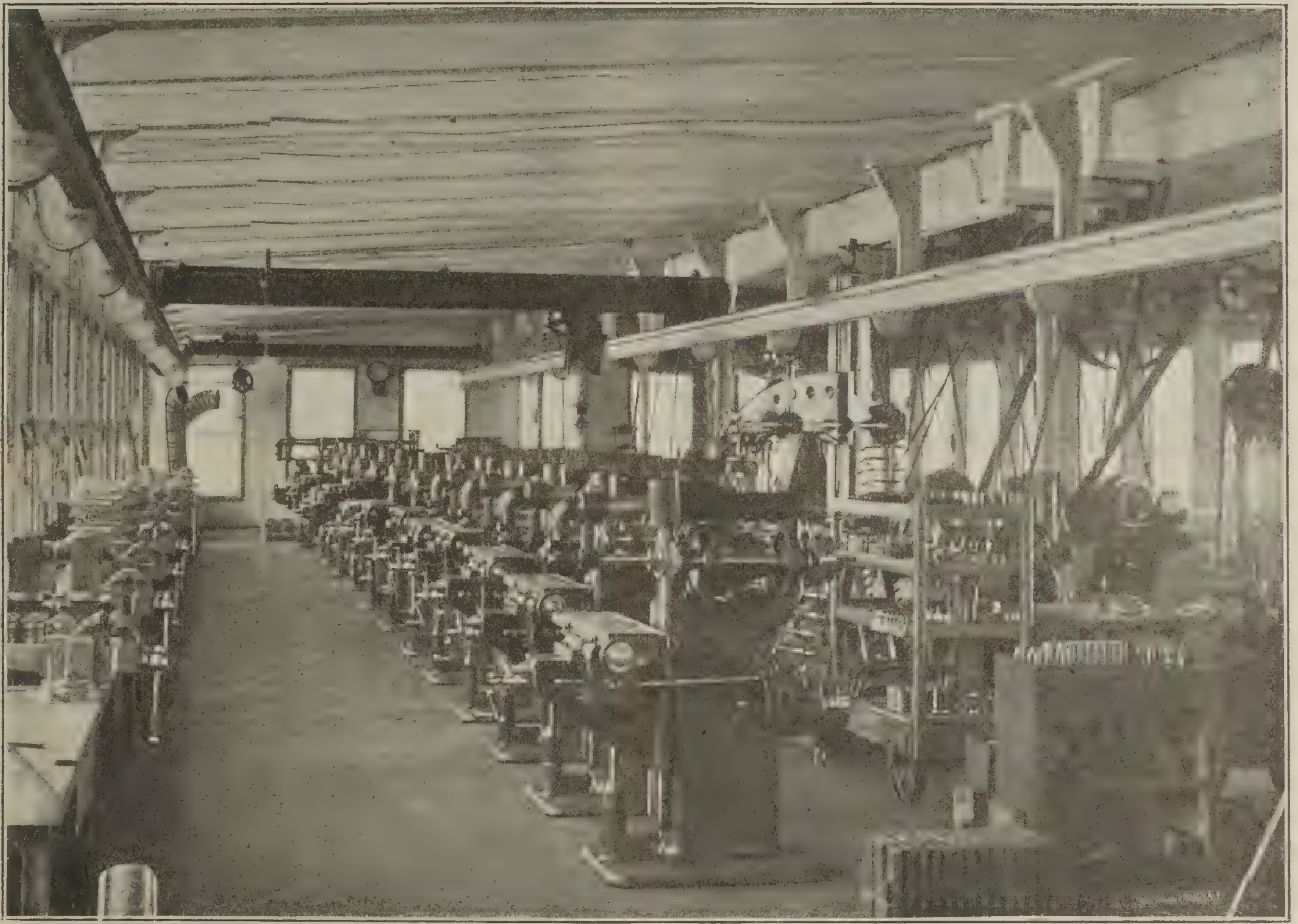


Fig 6. Milling Machine Erecting and Fitting Department.

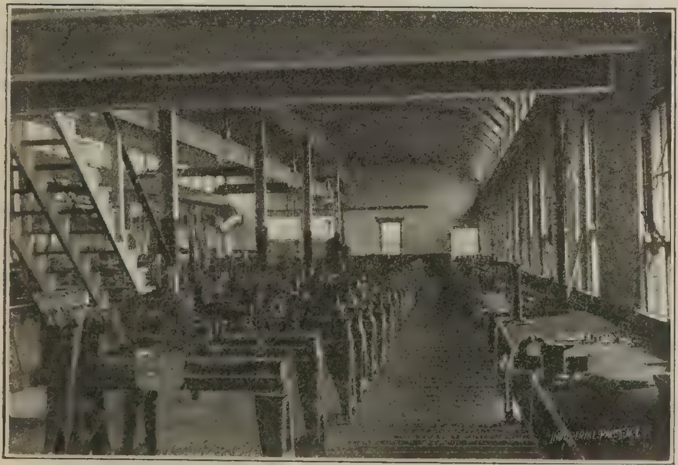


Fig. 7. Small Lathe Assembling Department.

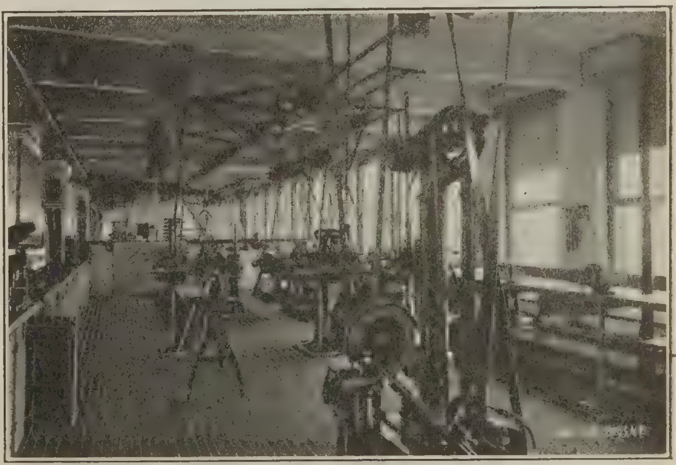


Fig. 8. Manufacturing Tool Room.

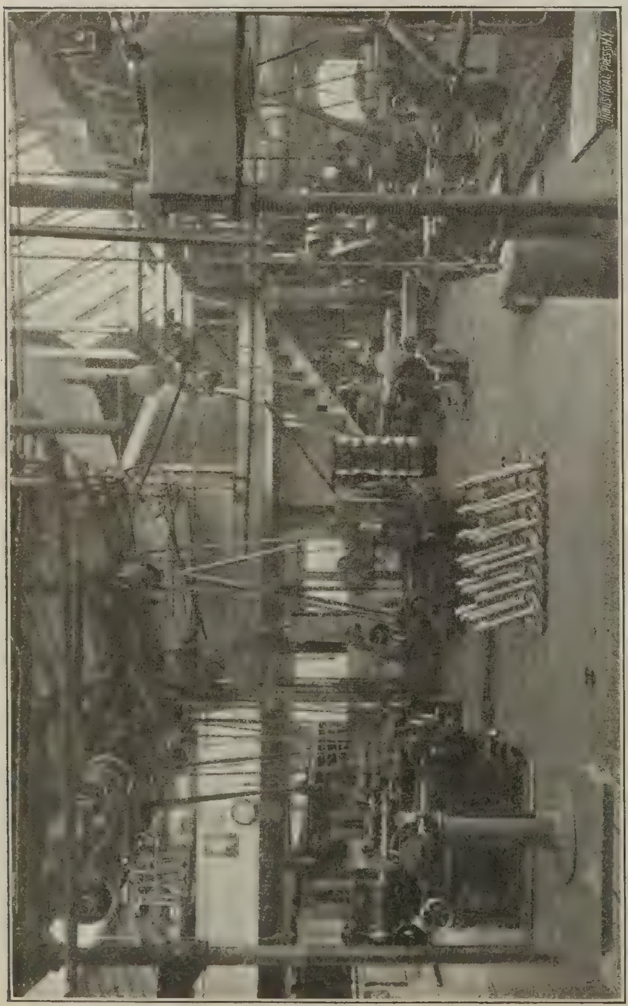


Fig. 9. Gear Cutting and Milling Department.

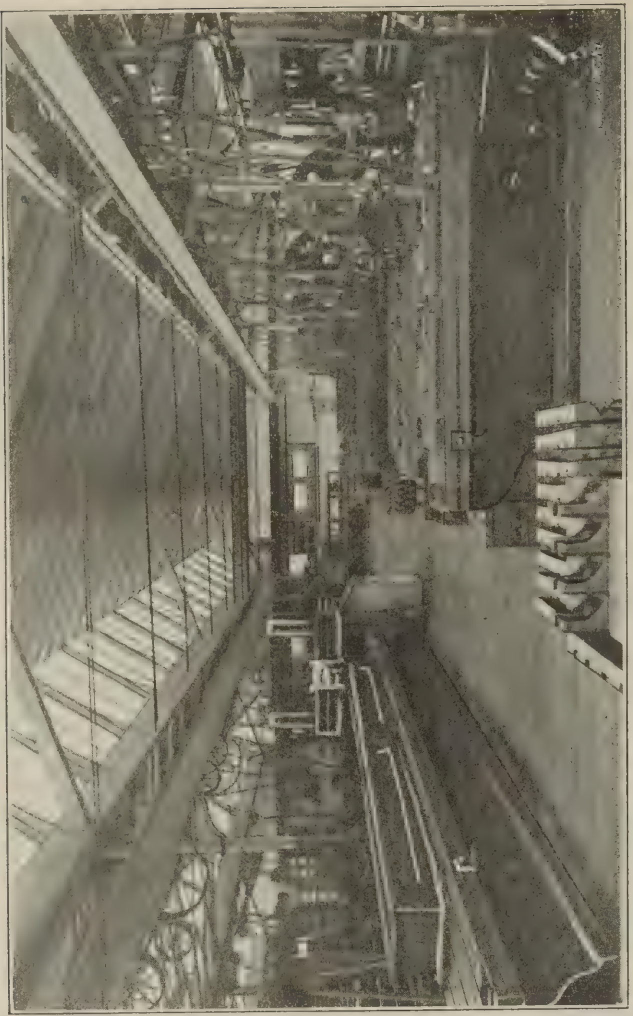


Fig. 10. Planing Department.

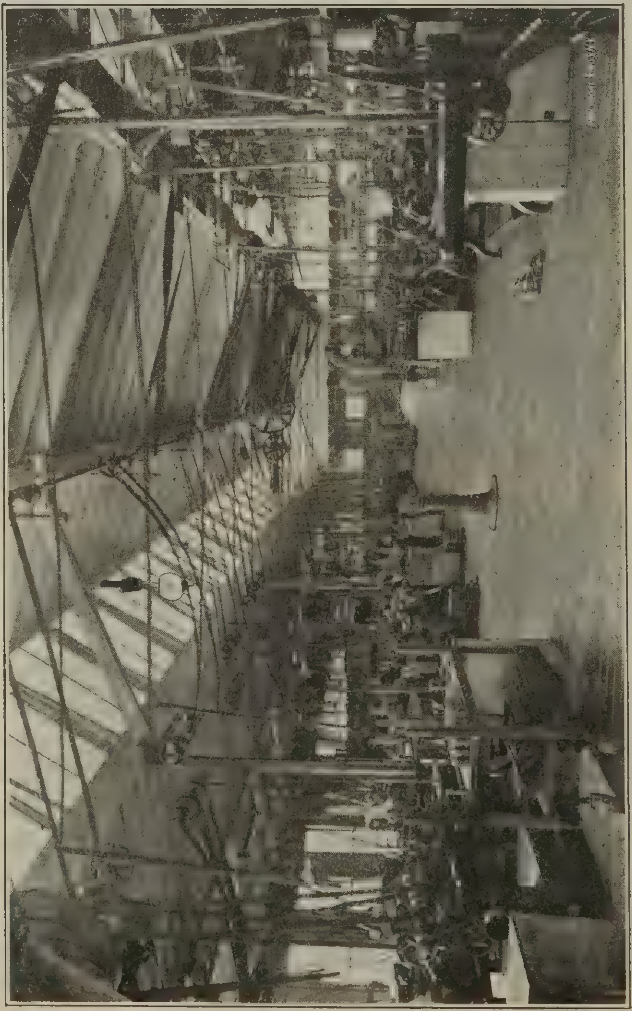


Fig. 11. Lathe Department.

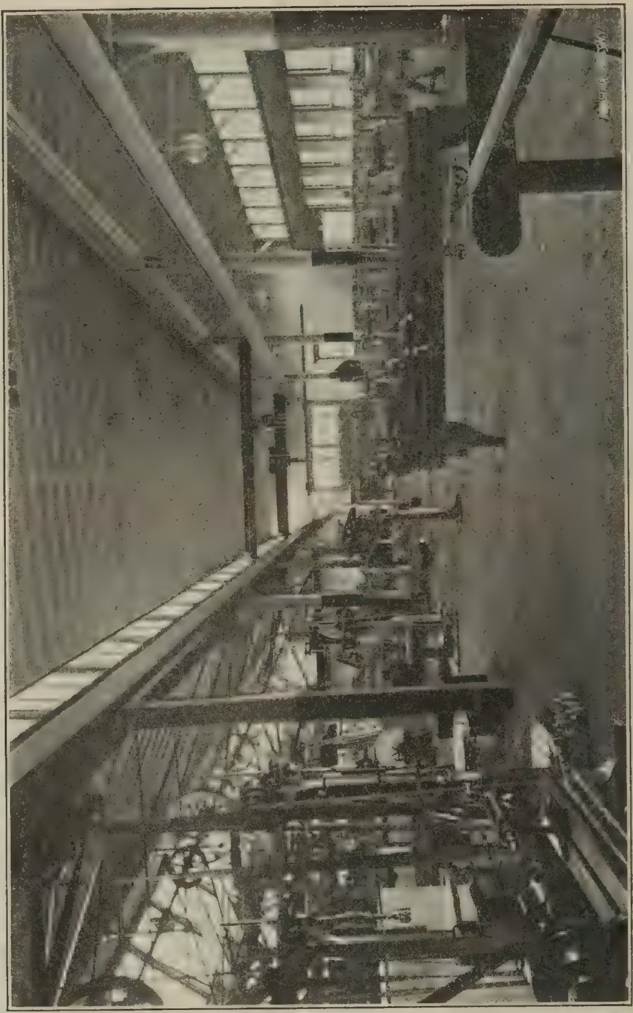


Fig. 12. Large Lathe Erecting Department.

placed in the discarded file. Blueprinting is done by sunlight, a frame being provided which slides out upon the roof. This frame is something of a novelty, inasmuch as it is so constructed that the glass automatically lifts from the paper when the frame is drawn in, thus enabling the print to be removed and another paper substituted quickly. This is done by the glass frame riding up on an inclined way as the frame is pulled in and, of course, when the frame is pushed out again the glass descends and holds the copy and blueprint securely.

The location of the main toolroom is indicated in the floor plan, Fig. 2. A great variety of gages and jigs are provided, as becomes a shop in which manufacturing is done on the interchangeable plan. Part of the gages are kept in four-sided revolving cases standing out on the toolroom floor, which arrangement makes for the convenience of the toolroom attendant. All tools, of course, are given out on check and strict account is kept of this valuable and indispensable part of the shop equipment. Micrometers also form a part of the toolroom gage and measuring apparatus, and are given out on check the same as other gages. The stock of special tools, such as cutter bars, reamers, end mills, special mills, etc., is large, being so not only because of the necessity of duplication but also because of the variety of the work and the extent to which the interchangeable feature of the manufacture is carried out.

The machine tool equipment embraces a number of special machines of which the index-plate drilling machine illustrated and described in the March, 1904, issue is a good example. Another interesting machine, but of a simpler order, is a machine for milling the faces of cone pulleys. A cut of this machine is not shown, but its principle is simple enough to be made clear without it. The work spindle carrying the pulley stands at right angles to the cutter spindle, an inserted cutter end mill being used. Both spindles are in horizontal planes. To mill an approximately flat face pulley the projected cutter spindle axis should pass through the vertical middle plane of the pulley and it should be raised (or depressed) so that the teeth sweep arcs on the face of the pulley at the end of its horizontal diameter. But now if the cutter be depressed a short distance, its alignment and that of the pulley remaining the same, the cutters cut a rounded face on the pulley as it slowly feeds around, the reason being that the cutters as they sweep arcs over the pulley face are nearer the pulley center when at the sides than when over the center of the face.

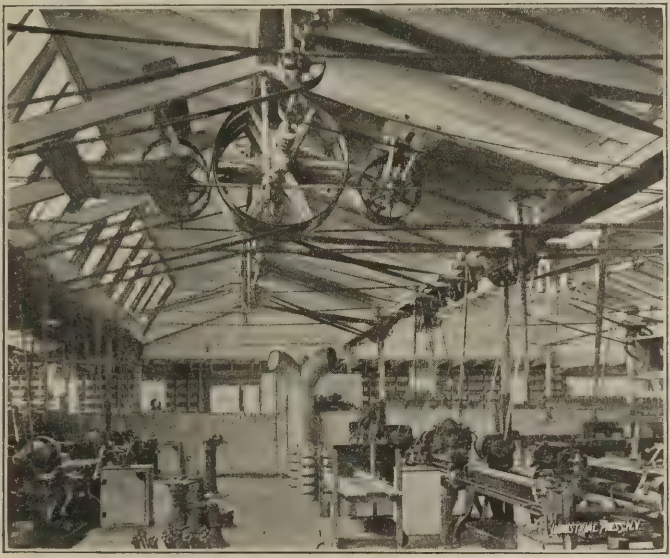


Fig. 13. Main Line Shaft and Belt Drive.

Fig. 14. Stock Room.

Fig. 15. Experimental Department.

Fig. 16. Private Dining Room.

All planer work is jigged, the fixtures being of the simplest form. Clamps with tapered horns engage the cored holes of lathe headstocks and tailstocks for the first planing operation, which insures that the cored holes will be concentric with the casting when being bored. The planers, as already stated, are mounted on a masonry and concrete pier, which insures them a solid and permanent foundation. A further precaution to insure a solid and equal support all around is the use of small sole plates or shoes with wedges operated by screws. One of these is placed under each planer foot, thus giving the immediate means of leveling up if necessary. Fig. 10 shows a portion of the planing department with the planer for long lathe beds at the left.

Lathe leadscrews are cut in a special lathe fitted for the purpose which cuts chips from the screw with the carriage coming or going. The special tool-holder used on this lathe, is shown in Fig. 17. There are two tools in front and two at the back, the front tools being in operation, of course, when the work is running forward, and the rear tools being used when the work is running backwards. In this way no time is lost running the carriage back to take a fresh cut. The screw is deluged with lubricant so as to maintain the lowest possible temperature consistent with the rapidity of the work. Each pair of tools is disposed in the holder so that one tool cuts the stock away from the bottom of the thread while the other attacks the side toward which the carriage is traveling.

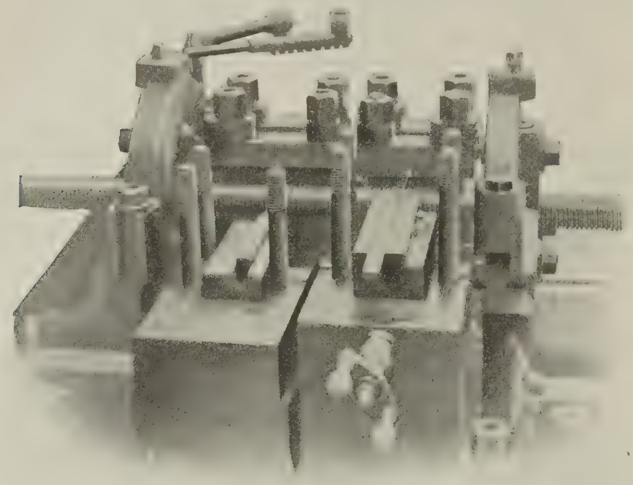


Fig. 17. Special Tool Holder for Cutting Lead Screws.

The production of leadscrews cut in this lathe is said to be quadruple that of an ordinary machine, and much more accurate.

The bearings of lathe headstocks are bored on a horizontal boring mill with the headstock held in jig having large bearings in line with those being bored. These jig bearings are provided with bushings which turn with the boring-bar, being keyed to same, so that the latter is free to feed through them. The connection of the jig boring-bar is made to that of the boring machine by means of a universal joint so that the alignment of the boring-bar is in no way affected by the set up of the jig on the boring mill table. Substantially the same rig is now used by most of the lathe builders of Cincinnati.

The milling machine erecting and fitting department is illustrated in Fig. 6; and a set of boring tools and reamers used in finishing the main spindle bearings, also the back gear and overhanging arm holes, is shown in Fig. 18. A large cast-iron jig embraces the frame which is tipped down, as shown in Fig. 18, on a special truck used for the purpose. In this position the radial drill seen in Fig. 6 is employed to drive the bars for boring and reaming. The bars are supported in revolving bushings the same as in the lathe headstock jig, that is, so that they revolve with the bar and prevent wear of same. The connections of the bars with the spindle of the drill are of a flexible or semi-universal joint order, making the alignment of the bar absolutely dependent upon the jig. It will be observed that all three holes are finished at the same setting, perfect parallelism being thus assured.

Great care is taken in the details of the main spindle and its fitting. The spindle journal next the nose consists of a hardened steel bushing, tapered exteriorly and ground after being pressed on the spindle. This hardened bushing runs in a cast-iron bushing pressed into the frame and held by a nut. The wearing durability of this combination is said to be unsurpassed if it receives ordinary care. While cast iron is prone to cut with soft steel journals it has very little tendency to do so with hardened journals. The spindles of the smaller milling machines are aligned with the knee and table so that they are "out" 0.001 inch downward and the same amount sideways when new, the idea being that by the time they are in good working order the side thrust due to the feed and the vertical thrust will have practically corrected the error. The practice is one that is said to work satisfactorily, as it insures a longer period of approximate perfection than would be the case if the parts were perfectly aligned in the beginning. This is self-evident.

There are so many mechanical practices and devices of which it would be interesting to speak, but which are barred because of space, that it is somewhat difficult to select representative examples. The manufacture of the milling machine and its accessories is of particular interest. Special attention is given the construction of the index head. The wormwheels are cut in a fixture which rotates the wormwheel positively while being hobbed and the master wormwheel is of large diameter to reduce the error of division to the minimum. After being cut they are "jacked" to rub down the slight roughness caused by the hob. The parts of dividing heads as well as the other parts of the machines are made strictly on the interchangeable plan.

In the screw machine department the system of making forming tools is worth a special description and this we may take up in a future article. A circular templet is first turned in the lathe of the same contour as desired on the work. A longitudinal groove is then milled with one side radial. This forms an accurate templet to which the tool can be fitted. It will be appreciated that in turning the templet in the lathe the operator has at his command the use of the compound rest by which angles of any degree can be laid off exactly, faces can be made absolutely square with the length and measurements made with micrometric exactness. Templet making, ordinarily a difficult and inaccurate process, is thus quite simple and great accuracy is readily attained. Many gang-tools are made in the same manner. For instance a gang cutting-off tool is used for making washers. Four washers are cut off at the same time, one following the other in being severed from the stock, of course. Of a certain size four washers are cut off in 4½ minutes where it formerly took 3½ minutes to cut off one. Cleveland screw machines are used. A troublesome feature of screw machine work is the chips and the separation of the oil. In this department the chips are shoveled into a large galvanized tank (about 2 x 3 x 4 feet) on wheels, which has a false perforated bottom. The chips are cleaned out of the chip pans at night and are shoveled into the tank, which can be conviently hauled around for the purpose. During the night the oil drains into the bottom leaving the chips quite dry the next morning. They are then "whirled" in the centrifugal separator to recover the small amount of oil still adhering. This practice is said to work a considerable economy in saving of oil.

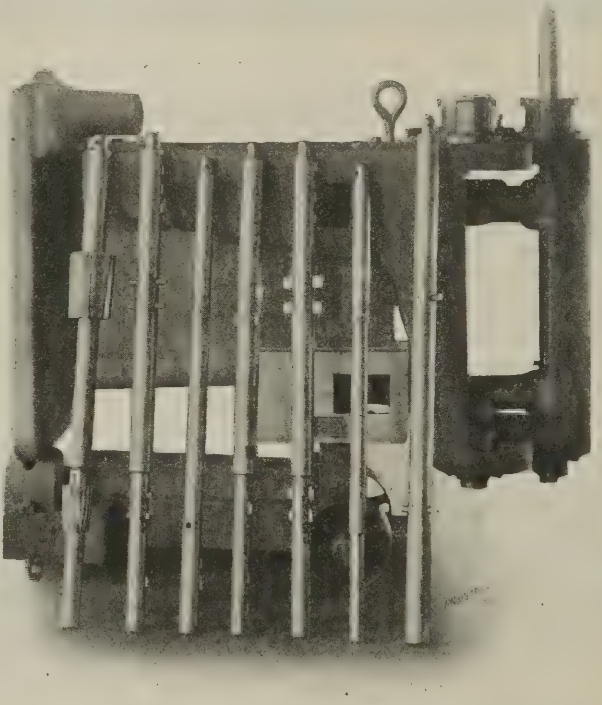


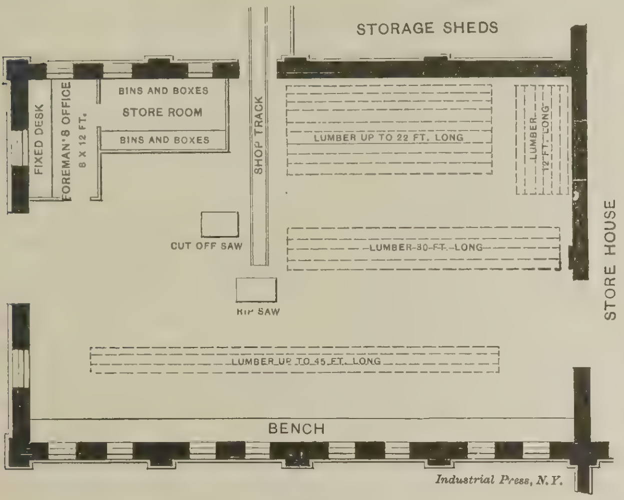
Fig. 18. Tools for Boring Main Spindle Bearing of Milling Machine.

MACHINE SHOP EQUIPMENT.—8.

MISCELLANEOUS EQUIPMENT.

OSCAR E. PERRIGO.

In this, the concluding article of this series, it is proposed to take up the smaller departments, special rooms, etc., in the same manner in which the subject has been treated in the previous articles and to give such a detailed description, in connection with the engravings, as to make the matter as complete as in any of the more important departments of the plant.



Industrial Press, N.Y.

Fig. 1. The Carpenter Shop.

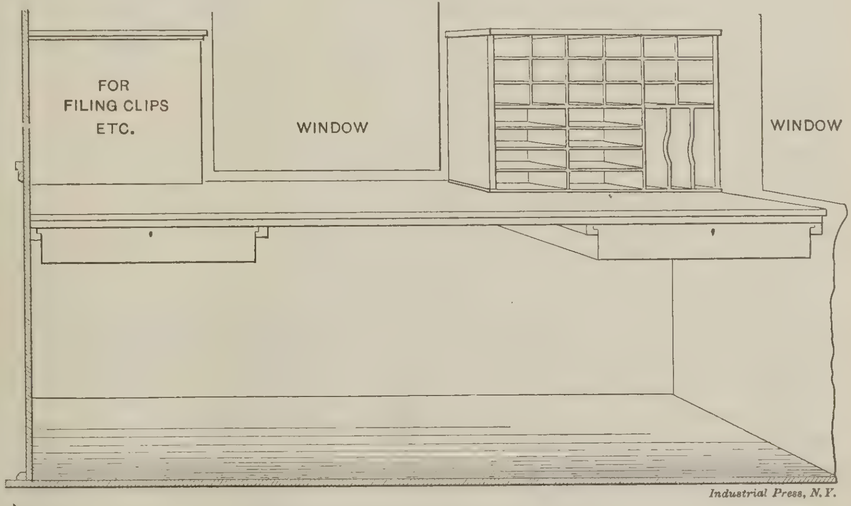
To many casual readers, or superficial observers, who may have read these articles it has doubtless appeared that very many of the matters considered have been treated with too great a regard for the smaller details and the minor points which, in their way of thinking, might be easily decided and disposed of at any time without much study as to just how this or that matter could be best handled, or this convenient accessory be best located, arranged or equipped. This ignoring of details, assuming them to be trifling matters, has often been the cause of much disappointment and useless expense, because what was, at the time, considered a trivial matter has, under perhaps somewhat unusual conditions, and sometimes under the most ordinary conditions, proven to be much more important than at first supposed, and given no end of trouble before being finally arranged in a thoroughly and practically satisfactory manner.

To practical men who have had experience in the designing and arranging of the various machine shop departments and accessories, or of those of a manufacturing plant, so as to afford the best accommodations and facilities for the class of business to be done there, at a reasonable economical expense; and to those who have had years of practice in superintending and managing the daily routine therein, it has doubtless occurred that there were many points in these articles that should have been much further elaborated, and whose details should have been gone into more thoroughly and explicitly. For these men know the annoyance, the disturbance of daily routine work, the inconvenience and the expense of alterations, changes and rearrangements that it has been their lot to encounter and their duty to remedy, in order to bring efficiency out of the ill-advised and unpractical plans and get everything running smoothly and satisfactorily.

The carpenter shop is located near the rear of the plant, between the machine shop proper and the forge shop, and adjoining the store house, or shipping room. Its internal arrangement is shown in Fig. 1. In this department should be stored the lumber and other packing material necessary for shipping, as well as for doing the miscellaneous carpenter work required about the plant. This material may be brought in on the yard cars by way of the track entering the side door; or, if received by the steam railroad cars, it may be brought in through the store house—a distance of only fifty feet. Lumber in long or short lengths will probably come in on the steam railroad cars, as it should be purchased in carload lots. It may be unloaded upon the yard cars at the rear gate and run directly into the carpenter shop. Convenient methods are shown, by dotted lines, in the engravings for locating the different lengths of lumber so as to render any length readily accessible without disturbing any other length. Ordinarily the lumber will be piled on the floor, but light, thin lumber, matched sheathing, etc., may be placed in racks overhead, where it will be more out of the way and safer from accidental injury. Box stuff cut to dimensions, as well as made-up boxes, may be similarly stored so as not to unnecessarily encumber the floor space.

In the outer corner of the shop is an inclosure serving as an office for the foreman. It is built of ⅞-inch matched sheathing to the height of 42 inches and above this height it is composed of a galvanized iron wire netting 4 feet wide and of 1 inch mesh, attached to a frame of 2 x 3 scantling, placed not over 5 feet apart, and forming also the framework supporting the sheathed portion below. The wire netting is tightly strained upon this and fastened with 16-ounce tacks, after which a face casing ½ inch thick and 3 inches wide is put on, along the top and bottom and vertically at each upright. A cap 1 inch thick and 3 inches wide is placed on top. At the top of the sheathing a 1 x 2 inch strip forms a cap, underneath which a ½ x 1 inch strip forms the finish. Doors may be conveniently made with side and top stiles 1 inch by 4½ inches, and the middle and bottom stiles 1 inch by 6 inches, all "halved together," glued and screwed, and covered with the wire netting, and finished with a facing strip ½ inch by 2 inches, mitered around each panel to cover the edges of the wire netting. These are very strong and quite light and answer the purpose admirably. The object of constructing inclosures in the shop in this manner is to obtain a reasonably secure partition, and at the same time one that will offer as little obstruction to the light as possible, and also permit as free observation of the various parts of the room, as well as of the inclosure itself. This method has been found in practice to be strong, durable and economical.

Along the side of this inclosure, next to the wall, is a fixed desk of proper height for a man standing, say, 41 inches. It should be 24 inches wide and incline to the front about 2 inches in its width. Upon it, and in the corner between the two windows, should be placed a suitable pigeon-hole case, not over 24 inches high and 8½ inches deep. The top, bottom and sides are of ⅞ inch white pine and the partitions are of ½ inch stuff. This, with the desk, should be protected by two or three coats of shellac varnish. This case will be used for holding such blanks, slips, memoranda and similar papers as are in use. Proper space should also be provided for the necessary books relating to the carpenter work, boxing, skidding, shipping, and similar work. At the left-hand side, and



Industrial Press, N.Y.

Fig. 2. Fixed Desk, Pigeon Holes, Etc.

between the window and the partition, there should be fixed to the brick wall a board of the same height as the pigeonhole case for convenience in hanging filing clips and for similar purposes. Beneath the desk should be two drawers, about 5 inches deep, 24 inches from front to back and 30 inches wide, and provided with locks. Such an arrangement of desk, pigeon-hole case, drawers, etc., is shown in Fig. 2, which will give a general idea of its appearance and usefulness as well as of its economical construction.

The particular description here given of such fittings as these will apply to the design, arrangement and construction of similar cases, racks, shelves and other divided spaces necessary in many other parts of the plant, and we shall be well repaid for the time spent in carefully designing them to meet the special conditions and objects for which they are to be used, and shall often be enabled thereby to save quite a percentage of the time of the employees using them. They may be constructed by any good carpenter and will be in many respects the best as well as the most useful.

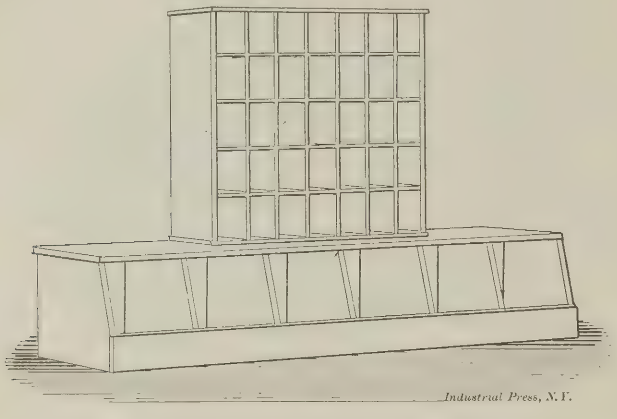


Fig. 3. Case for Lag Screws, Nails, Spikes, etc.

Adjoining the foreman's office and opening out of it is a similar inclosure, to be used as a store room for the carpenter shop and to hold such articles as may be much more conveniently kept here than in the principal store room, in the office portion of the plant, to be drawn in small quantities as needed. Against the wall is a case containing a row of bins for holding nails, spikes, etc. They are constructed of sufficient dimensions to hold a liberal supply of each size of nails and spikes, and the front board is made quite narrow, not over six inches high, to facilitate the removal of the contents. Above this row of bins is a case for lag screws, etc., containing thirty-five boxes, this being amply sufficient for all the different sizes usually needed. The width of this case is determined by the distance apart of the two windows between which it is located. At the left of this case, standing on top of the bins, and in front of the window, should be a small counter scale for weighing such articles as may be used or issued and are to be accounted for by weight. A perspective view of this case and the row of bins is given in Fig. 3.

On the opposite side of the store room is a somewhat similar case for holding nuts, washers, etc., in the bins, and having above it a case with forty-two compartments for machine bolts, carriage bolts, etc. A perspective view of this case is given in Fig. 4. Both of these cases are made of ⅞ inch pine and painted. The top of the bins is 24 inches from the floor. That shown in Fig. 3 is 6 feet high, but the one shown in Fig. 4 is limited to 5 feet so as not to unduly obstruct the light. The base of the bins is 18 inches wide. The depth of the upper cases is 8½ inches. In the construction of cases of this kind it is well to remember that they may be made of an ordinary quality of pine commonly called "box boards," planed on both sides. The horizontal boards or shelves are first put in, the ends resting on cleats screwed to the uprights at the ends of the case. The upright partitions are cut to the correct length on the cutting-off saw, set in place and "toe nailed" in front, and nailed through the back. All the shelves and upright partitions should be ⅛ inch narrower than the uprights at the ends, while the top should project ½ inch at the front and ends. The bins may be built in place, nailed to the floor, but it is sometimes desirable to have such fittings built separate and set in place when completed, so that they may be moved, in case it should be necessary to do so, without partially or wholly destroying them.

The location of the piles of lumber is indicated by dotted lines, and the capacity of the space is marked in each case. At the side of the yard track entering the carpenter shop is a cutting-off saw. This may be one with a sliding table, upon which the lumber to be cut is placed and moved toward the saw. But for rapid work a swinging saw, pivoted overhead, and quickly moved in an arc across the piece of lumber, is preferable for the ordinary rough work called for in the carpenter shop. Of course, such a saw must be carefully protected so that the careless use of it may not be dangerous to the workmen. Near the cutting-off saw is the rip saw, but located at right angles to it so that long lumber may be handled, and in order to increase this capacity it is placed between the two doors, thus permitting the handling of lumber of almost any length. A work bench occupies the entire length of the inner side of the shop, furnishing an ample space for five men at bench work. It is fitted with removable vises in order that long work may be handled if necessary. A door 10 feet wide leads into the yard and one of the same width into the store house. These should be sliding doors, the latter a properly protected fire door. A side door 4 feet wide gives entrance to the tram track from the yard. In the large, outer sliding door it is well to put a small swinging door, say 30 inches wide, for convenient use in winter, to avoid the necessity of sliding the large door for the passing in and out of the workmen.

The store house adjoins the carpenter shop, communicating with it by way of the 10-foot fire door just mentioned, and with the rear end of the machine shop by a 14-foot sliding door, also arranged as a fire door. The relative position, as well as the complete plan, is shown in the engraving in Fig. 5. A steam railroad track runs along the rear of the entire plant, and as closely as may be to the shipping doors of the store room. These are three in number, one of 12 feet, and the other two 8 feet in width. Six windows in this side and four in the end of the store house afford sufficient light for the usual purposes. The floor of the store room is raised above the floor of the machine shop to such a height that the top of the platforms of the cars running on the machine shop floor track will be the exact height of this floor. A portion of the floor of sufficient width to admit a shop platform car is cut out, as shown in Fig. 5. By this means machines may be placed on these cars by the traveling crane in the machine shop, run into the store room and unloaded on the floor at the exact level with the top of the car platform. From here they may be taken on rollers (if they are skidded) or on machine trucks, and put in their proper places on the store room floor. At each of the three shipping doors there should be an I-beam extending out over the railroad track, upon which is mounted a trolley hoist, preferably operated by compressed air or electricity. These I-beams should extend back, at least to the center of the store house, and better still, all the way across it. They may be connected by lateral I-beams, by curves, by turntables, etc., so that nearly all parts of the store house may be effectively covered. The lateral tram car tracks will prove a valuable adjunct to this system in moving machines from place to place on the store house floor.

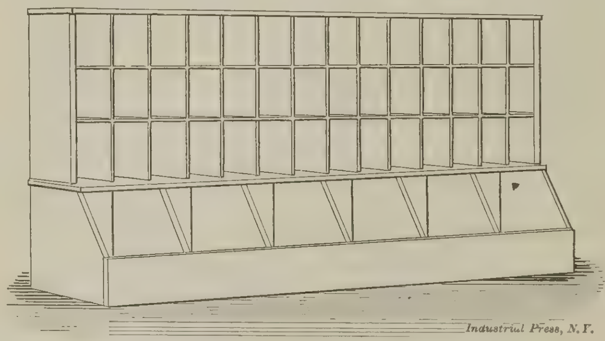
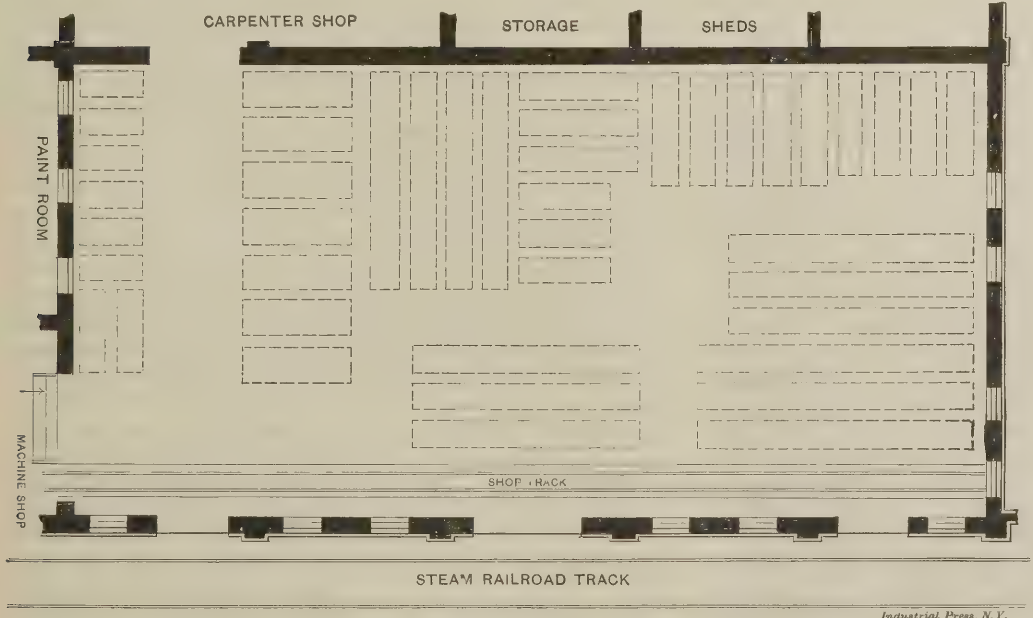


Fig. 4. Case for Machine Bolts, Nuts, Washers, etc.

In storing machines of various sizes in the store house while awaiting shipment it is frequently difficult to get at just the size of machine wanted without the trouble and expense of moving several others, for it is a common saying among shippers that "it is always the machine in the furthest corner that we want." In the dotted lines in the plan, Fig. 5, is laid out an arrangement of machines of a dozen different sizes, in such a manner that any size may be brought out for shipment without materially disturbing those of any other size. Of course this shows an arbitrary lot of sizes, but the plan here used, of reserving central aisles with cross aisles at proper intervals, is a plan which store room men and shippers will do well to familiarize themselves with and to adapt to their special needs by changing it to suit the particular class of machines with which they have to deal. In the case of small machines that may be stored on shelves, provision should be made for them by arranging shelving on the alcove plan, similar to that employed in storing patterns in the pattern storage room. In such cases such trucks as heretofore described in these articles may be advantageously used, the truck wheels being located so as to fit the regular shop track. Manufactured machines may then be handled with very little labor of loading and unloading, the use of the overhead trolley being brought into requisition whenever possible. Branches from them may be run over the centers of the alleys between the sections of shelving as may be necessary.



Industrial Press, N.Y.

Fig. 5. Store House.

In all manufacturing establishments making machines in whose construction cast iron enters considerably, there is more or less painting required. The present demand is for very clean, smooth work, finished with some one of the various machine enamels. These enamels, so called, are to a great extent composed of a pigment mixed with some kind of varnish, usually of gum copal, thus forming the "air drying enamel," in contradistinction to the "baking enamel," so much used on bicycle parts and similar work. In the manufactory of the kind under consideration the machines will usually be of a size to render their removal to a special paint shop, and from thence, after painting, to a store house, a matter of considerable expense. They are, therefore, painted in the erecting departments, and the expense of providing a special painting department is avoided. Still there must be a safe and proper place for keeping paints, oils, and other painters' supplies and materials, and also to serve as a sort of shop for the painters. This kind of a room is shown in Fig. 6. It is located between the store house and the machine shop. The floor should be of brick, hard asphalt or concrete. On the side toward the store house are bins for holding dry colors. These should be raised three inches from the floor, and be constructed of ⅞ inch pine, similar in form to the bins in the carpenter shop store room, but with covers hinged at the top, for excluding dirt. On each side of the door is a bench 2 feet wide and 30 inches high, for convenience in mixing paints. Over each bench is a series of four shelves, 10 inches wide and placed respectively, 12, 10, 9, and 8 inches apart from the bench up. These will be convenient for storing small cans of ground paints, brushes, sandpaper and similar articles. Beneath the benches should be a shelf 16 inches from the floor, and each bench should be provided with a drawer 2 feet square and 8 inches deep, and furnished with a lock. The remainder of the space on the side toward the machine shop should be provided with a platform 16 inches from the floor, for holding barrels of oil, turpentine, etc., on their sides, and for barrels of such dry materials as it is not desirable to put in the bins. If considerable lampblack is used there should be a large galvanized receptacle, round or square, with a tightly fitting cover, for its storage, as there is always the danger of spontaneous combustion to be feared from it. Beneath the oil and the turpentine barrels there should be a drip pan of strong galvanized iron. The use of the lighter petroleum products such as gasoline should be avoided, if possible. If we are compelled to use them a separate store room should be built in the yard. It should have an iron roof, as a matter of ordinary protection. Any inflammable materials of this kind in use in the shops should be returned to it each night and taken out in the morning. The paint room should, of course, be always locked when none of the painters are working in it.

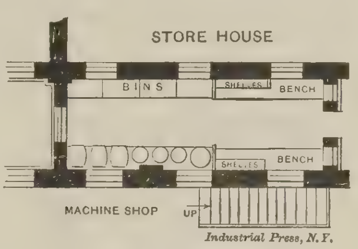


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Fig 6. Paint Room.

The wash rooms as well as the water closets are located in the rear portion of the power house, and upon each floor, the upper floor on a level with the floor of the machine shop galleries, this location being midway in the length of the machine shop proper, so within the most convenient distance from any point in the shop. There are two doors opening from the machine shop, one to be used as an entrance and the other as an exit door, to avoid the confusion that would otherwise take place if workmen going both in and out were to come in contact during the rush of the men in washing up and leaving the shops at quitting time. A series of lockers are located on each side of the room its entire length, and a double row located in the center of the room. These, with a few at either end, will give one hundred and twenty-eight lockers in the room. There are, of course, an equal number in both the upper and the lower rooms. In some of the departments, for instance in the small parts store room, and the assembling rooms,—perhaps in the grinding room, the carpenter shop, etc.,—the workmen may be provided with lockers in their work rooms, but the system can be better cared for by not breaking it up too much. Between the rows of lockers are the wash sinks, constructed after the plan shown in the article on iron foundry equipment, affording fresh, clean water to each man. The water used by the men for washing may be warmed in winter by passing it through a steam heating coil, and the difference in the temperature of the water no doubt would be much appreciated by the men.

The windows along the outer wall of the wash room are placed high enough in the wall to be above the lockers, which should be constructed of expanded metal, or its equivalent, but never of boards, or in any way to prevent the free circulation of air, and of sanitary cleanliness.

The water closet room opens from the wash rooms. Windows open from each side, and there is an additional one at the far end. Those on the sides are placed high enough to be out of the way of the water closets on one side and the urinals on the other. There are eighteen water closets and twenty-one urinals in the room. The urinals are divided by partitions 2 feet wide and 5 feet 8 inches high, and the water closets are 32 inches wide and project 4 feet from the wall. Each closet is provided with a light door having double swing, spring butts, and a sliding bolt on the inside. These doors should not reach the floor by about 12 inches, and should extend to the top of the partition. The partitions should be 5 feet 8 inches high. All partitions of the water closets or urinals, if of wood, should be well painted with a heavy mineral paint, the last coat being of enamel, the preferable color being a steel gray, which is very hard and durable and will stand much washing. It will be better, of course, if these partitions are of metal, similarly painted They may be of cast iron ⅜ of an inch thick, strengthened by suitable ribs. For the water closets wooden partitions will be preferable. The floor should be of some non-absorbent material with no seams or joints to retain offensive odors. A smoothly surfaced cement composition, such as is used for sidewalks, and commonly called "artificial stone" will be the best that can be put down at a reasonable expense. For the second story this may be laid, 2 inches thick, over a wooden floor composed of 3 x 4 inch scantling laid on edge. A similar floor will be suitable for the wash rooms, and much more economical, in the long run, than a wood floor, which will have to be renewed in a few years as it will decay from the constant wetting from the wash sinks. On the ground floor the cement surface may be prepared for by broken stone, etc., similar to the usual shop concrete floor, only not nearly so deep. All the piping for the water supply and for sewer connections should be in plain sight so as to be easily accessible when necessary to make repairs. The urinals should be automatically flushed with an ample supply of water at short intervals. The drainage pipes from the wash room should be utilized for flushing the sewer connections of the water closets and the urinals.

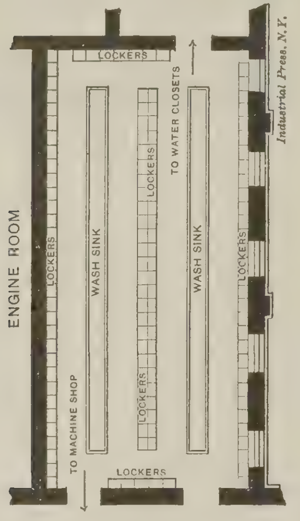

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Fig. 7. Wash Room.

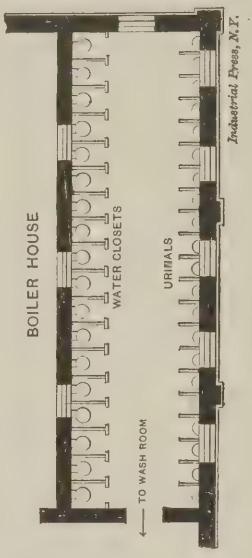

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Fig. 8. Water Closets.

The water closets and urinals provided for the machine shop will be used also by the carpenter shop and the store house employees, but these employees may have lockers located in the carpenter shop, if desirable, and they will doubtless be better satisfied with such an arrangement. The wash rooms and water closet rooms should be in charge of an attendant whose duty it will be to see that everything is in proper working order and that sanitary regulations are strictly observed.

TOOL MAKING.—5.

TAPS.

E. R. MARKHAM.

Taps, if improperly made, are a source of great annoyance, and so few men understand how they should be made that in shops where taps and screw-thread dies are extensively used it is customary to keep one or more men exclusively on this class of work. These men, of course, become expert tap and die makers. Yet if a few important points are observed and a man possesses patience and a good supply of common sense, he need experience no difficulty when doing this class of work.

It must be well understood that unless the shape of the tooth or thread is the same on both tap and screw that are to go into the tapped hole, trouble will be experienced when the tap is used. I do not mean by this that if screws are made with threads improperly shaped we should make taps equally out of shape to match the screws. If taps and dies are properly made, and due care exercised when they are used, there will be but little trouble this way.

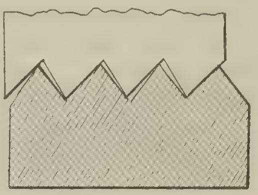

Fig. 1.

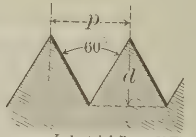

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Fig. 2.

It should be borne in mind that the sides of the thread should bear on the sides of the thread in the tapped hole. Now if the sides of the threads on the tap are at one angle and those of the screw another angle, as shown in Fig. 1, the screw cannot run in and out of the tapped hole many times before it is loose.

Another thing to remember is that the lead of the tap and of the screw should be as nearly alike as it is possible to get them. While it is a fact that taps are very liable to alter their lead when hardened by the ordinary method, and that screws cut with a die do not, as a rule, have the same lead as the die they are cut with, yet the difference can be overcome in a great measure if the tap is hardened by the method known as "pack hardening," and the die properly made and hardened by the same method.

Having observed these precautions it is necessary to have die holders made that will bring the die in correct alignment with the spindle of the machine being used. Trouble is experienced at times by screws having a "stretched" thread, i. e., the lead is long. On examination, the die may be found to be properly made, but further investigation may show that the heavy turret slide of the screw machine was dragged along by the die when cutting and this drag caused the thread to stretch, making the lead long. These points are given to aid the beginner when attempting to locate trouble resulting from a difference in the lead of a tap and of the screw that is used in connection with it. Notwithstanding the fact, however, that dies oftentimes stretch the thread cut with them, it is often considered advisable to cut with a die the threads on *small* taps which are not to be used in tapping *long* holes; and if care is exercised very satisfactory work will result.

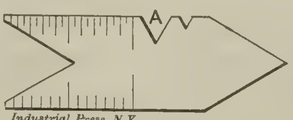

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Fig 3.

Various forms of dies are used in cutting threads on taps, formerly a jam die plate was used. The die used in this plate is made of two pieces of steel which have grooves at their ends to fit in ways in the plate. One part of the die can be moved back and forth to open and close it. It is pressed into the stock by means of a screw. Each time a cut is taken the desired length of the thread, the die is closed a little and another cut taken, which operation is continued until the thread is to the proper size. Or they may be left a few thousandths of an inch above size, and a sizing die run on to bring them to the correct size.

In shops where many taps of a size are made whose threads are cut with a die, it is customary to make dies of various sizes—the first die cutting a very shallow thread, and the finish die making it the required size. As many intermediate dies may be used as is deemed advisable; but for cutting the threads of taps ¼ inch diameter and under, three dies are generally considered sufficient. These may be held in one holder, or each die may be placed in a separate holder. If placed in one holder there is less liability of losing one of the set.

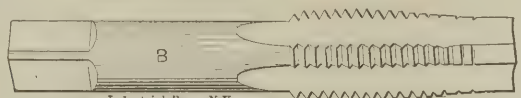

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Fig. 4.

The finish die should be made adjustable, so that it may be adjusted to exact size, and also to compensate for any wear when it is used. The other dies comprising the set may be made solid, as they will not require any change of size. These dies and the methods of making will be described and illustrated in a future article on "Dies."

As previously stated, taps whose threads are cut with dies are liable to have the lead changed somewhat; but as the screws to be used in the holes tapped with them are made in a screw machine, and their threads cut with dies also, their lead is also apt to be long. But the length of hole tapped is generally not very long, so the change in lead does not materially affect the fit.

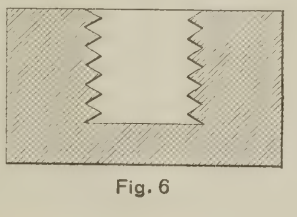

Fig. 6

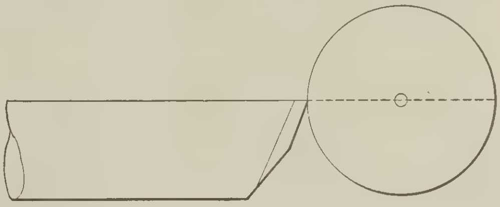

Fig. 7

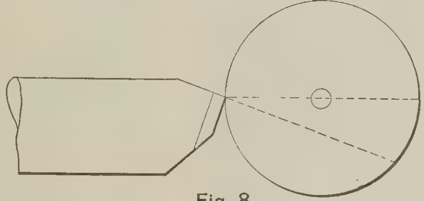

Fig. 8

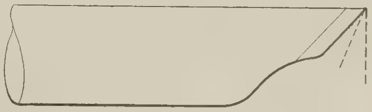

Fig. 9

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For the reader to clearly understand the term "lead" of a screw, as used in these articles, it has seemed wise to the writer to give here a brief explanation of the meaning of various terms pertaining to the number of threads in a given length of screw.

Lead of a Screw.—"Lead" is the term used to denote the distance a screw moves when turned once around. The "pitch" of the thread is the distance from the center of one thread to the center of the next thread, as shown in Fig. 2. The terms "lead" and "pitch" are often used to denote the same thing, and when applied to *single* threads this does not lead to confusion; but if applied to multiple-threaded screws, serious complications may result. For instance, a double-threaded screw whose "lead" is ½ inch—that is, where the screw must be turned twice around in order to advance it through one inch of space—when measured with a scale shows it to be ¼ inch "pitch." For a very complete explanation of the meaning of these terms we refer the reader to "A Hand Book for Apprenticed Machinists," by Mr. Oscar J. Beale.

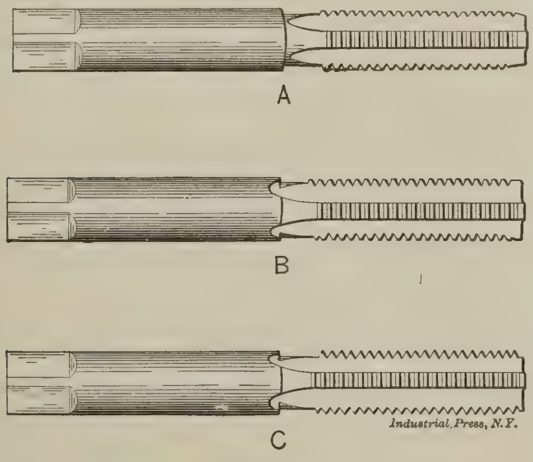

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Fig. 5.

When the threads of a tap are to be cut with a threading tool on an engine lathe it is essential that the tool be of exactly the proper shape; that is, the point must be ground to fit the 60-degree angle gage on one side of the center gage, as shown at *A*, Fig. 3. This is assuming that we are to cut either a V-thread or a United States Standard. Any other form of thread would necessitate shaping the tool to the angle called for.

As it is necessary to turn the blank to the proper dimensions before threading we will consider that before proceeding with instructions for threading. Stock—tool steel—should be selected enough larger than *finish* size to allow of removing all the decarbonized portion before it is to size. Care should be exercised when centering that the center holes are not made so large as to weaken the tap; neither should the countersinking be any deeper than is necessary. After removing the outer portion of the stock in the lathe, the piece may be annealed, provided it is ¾ inch diameter or larger. As to the most desirable method to use when annealing steel that is to be threaded for taps there is a difference of opinion among mechanics. Some claim that steel that is thoroughly annealed proves too soft, and tears in the process of threading and they recommend a "water anneal." Heat the steel to a *low* red, then hold in the dark until the red disappears, and the moment the red fades from view plunge in water. Soapy water or oil gives better satisfaction. Others claim best results if steel is heated red hot and buried in lime or ashes.

The writer always had good results when threading, if he annealed by heating to a *low* red, burying in a box with ashes, placing the tap between two pieces of board. The steel cooled below a red very quickly, but the boards which were charred from contact with the red-hot steel, kept the piece of steel hot for a long time. While a piece of steel must cool slowly when being annealed, to insure good results, it should not remain red-hot any longer than is necessary to insure its not being chilled, which would of course harden it. Yet it should cool very slowly from a point just below the red heat. Much of the steel that is annealed is subjected to heats that are too high, and this opens the grain and weakens the steel. As a result it crumbles off and tears when cut with a threading tool. So it is well to remember that steel exposed to a red heat for a long time grows weak and does not hold together properly when being cut with a threading tool.

If the tap is to be made of the form shown in Fig. 4 the portion marked *B* should first be turned to size, the squares milled, and the size stamped before the threaded portion is turned to size and threaded. When threading, set the point of the threading tool *exactly* at the height of the point of the lathe centers. If it is set above the center of the tap it will not cut well; and if it is set either *above* or *below* the center it will not produce a cut of the proper shape, that is, the angle of the tooth will be changed and it will not be of the proper shape.

For general shop use it is customary to make taps in sets of three, as shown in Fig. 5. These are known as "hand taps," and are operated by hand, using a tap wrench to turn them.

A set of hand taps consists of a "taper" tap, a "plug" tap and a "bottoming" tap. The former is used to start tapping a hole and is illustrated at *A*, Fig. 5. The plug tap is shown at *B*. This is used to tap a hole the threads of which must extend nearly to the bottom of the hole, as shown in Fig. 6. The form known as a bottoming tap is shown at *C*, Fig. 5, and is only used when it is necessary to extend the threads to the *bottom* of the hole. However, it is not customary to tap holes in this manner if it can be avoided; so taps of this character are used but little. However, they are generally included in a set of jobbing taps, as they are needed occasionally.

Having ascertained that the threading tool is of the proper angle, and in good condition, it is placed in the toolpost, the point of the tool being on the exact height of the point of the lathe centers, as previously explained. To produce a cut the exact shape of the tool the top of the cutting portion of tool must be on a line with the center of the piece being cut, as shown in Fig. 7. Should the tool be ground on top and set as shown in Fig. 8, with the point at height of center of the piece being threaded, it would not produce a thread of the proper angle. It is also essential that there be sufficient clearance given the tool to prevent its "dragging" or poor work will result. But we should be careful not to give the tool too much clearance, in the manner shown in Fig. 9, or the cutting portion will not receive sufficient support and will break off when in use.

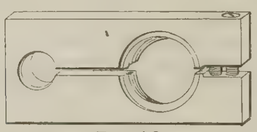

Fig. 10

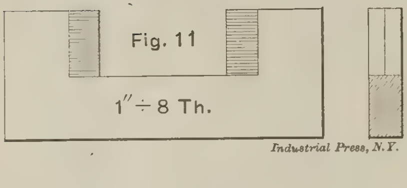

Fig. 11

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The tool properly ground and set, we proceed to cut the threads. In the making of taps a *smooth* thread must be cut, and to do this light cuts must be taken, especially when the threading is nearly completed. While threading, use lard or sperm oil to lubricate the cutting edge of the tool.

For threading taps some toolmakers use a single-pointed tool, while others cut the thread nearly to size with a single-pointed tool, finishing it with a chaser of the proper pitch.

When gaging the threading for size in some shops they fit the thread to a size gage, one form of which is shown in Fig. 10; while in other shops the size is ascertained by means of a gage made of sheet steel, as shown in Fig. 11. The contact points of this gage fit between the threads and gage the size on the sides of the lands. When many taps of *different* sizes are made the necessary number of gages of this character would constitute quite a considerable item of expense, and it will be found more economical to use a micrometer caliper of the form shown in Fig. 12. The range of one of these micrometers is somewhat limited, but for frequent use they form the cheapest as well as the most accurate gage.

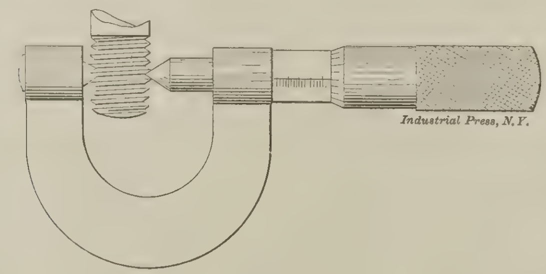

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Fig. 12.

Most toolmakers when threading taps consider it good practice to give them a *slight* taper, making them .00025 inch smaller at the shank end. This prevents their binding when the cutting end becomes slightly worn, while the taper is not enough to affect the accuracy of the lead. After cutting the thread the cutting ends of the taper and plug taps may be shaped as shown in Fig. 4, the end of the taper tap being made the size of the bottom of the thread back for a short distance, as shown. The plug tap is beveled to an angle that will extend back two or three threads. Again, some toolmakers think it best practice to shape the ends of the taper and plug taps before cutting the threads. This does very well when a drawing, or a model tap is at hand, but unless such is the case it is more satisfactory to have this done after the threading.

To provide cutting edges it is necessary to make flutes in the tap. These are generally cut in the milling machine, although in shops where no such machine is available they are fluted on the lathe. The milling cutter is held on an arbor which in turn is held between the centers, and is driven by a dog. The work is secured in centers on the cross feed slide, or some other arrangement may be provided for holding it. For instance, a hole may be drilled in a block of cast iron or other material and this may be fastened to the slide. Taps are sometimes fluted in the shaper or planer, using a form tool of the proper shape. This method, however, is not to be advocated except as a makeshift, as the tap is very apt to be sprung, or the lead changed by the operation unless extreme care is observed.

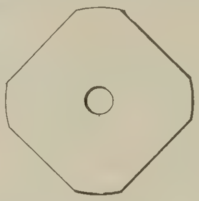

Fig. 13.

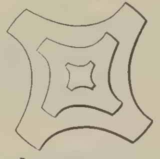

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Fig. 14.

Many changes have taken place during the past thirty years in the shape of the cutting edge. The writer remembers, when working as an apprentice, seeing taps which were made square, as shown in Fig. 13. The cutting edges were formed by the flat surfaces. The cutting edges not being properly shaped, there being very small space for chips, and the shape of tap being such as to cause the fine chips to be drawn back into the threads, it is needless to say the results were not as satisfactory as when a tap fluted as shown in Fig. 14 is used.

A milling machine cutter which is designed for cutting flutes in both taps and reamers is sometimes used to cut the flutes of taps; but it really is not adapted to cutting either, as it does not give the proper shaped tooth to either tap or reamer. To be sure it provides a cutting edge and a groove, but in the case of the tap the groove is cut too deep and the land when subjected to strain is apt to spring out into the work, and catch, and if additional force is then applied to move it, the tap as a rule breaks. A tooth cut with a cutter of this form, together with a portion of a cutter, is shown in Fig. 15.

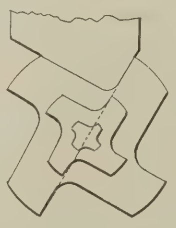

Fig. 15.

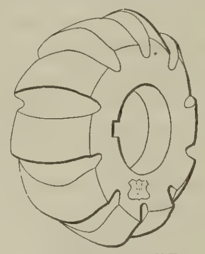

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Fig. 16.

Fig. 16 illustrates a form of cutter adapted to grooving taps only. These cutters do not make as deep a groove in proportion as the tap and reamer cutters shown in Fig. 15. They are made by the Brown & Sharpe Mfg. Co. The list of the number of cutter, together with the diameter of tap it is made to cut, is given below:

Number of Cutter.	Diameter of Tap.	Number of Cutter.	Diameter of Tap.
1	0 to $\frac{1}{8}''$	5	$\frac{11}{16}''$ to $\frac{7}{8}''$
2	$\frac{5}{32}''$ " $\frac{1}{4}''$	6	$\frac{15}{16}''$ " $1\frac{1}{4}''$
3	$\frac{9}{32}''$ " $\frac{3}{8}''$	7	$1\frac{5}{16}''$ " $1\frac{5}{8}''$
4	$\frac{7}{16}''$ " $\frac{5}{8}''$	8	$1\frac{11}{16}''$ " $2''$

It is necessary to make the flutes of hand taps somewhat narrower than for machine taps. This is so as to leave the lands somewhat broader in order to steady the tap when in use; for a hand tap is forced into the hole by hand, the force being applied at the ends of tap wrench handle, while machine taps are held steadily in position by means of a chuck or collet.

When cutters like that shown in Fig. 16 are used the groove should be milled to a depth that will make the land about one-quarter the diameter of the tap, provided the tap is given four flutes. Do not use a dull cutter when doing work of this character, for the work will spring, and in the case of taps the lead will be altered, as the tap will become elongated. The effect of using a dull cutter is similar to that produced by hammering a surface when pening it; it is stretched.

Clearance must be given the tap on the tapered portion at end so that it may cut. This is done with a file. Commencing at the heel of the tooth we carry the filing *to* the cutting edge, being careful not to remove any of this edge, for the tooth cut below the edge will do no work and the work will all be thrown on the remaining teeth. The strain in this case is unequal and the tap will not work as well as if each cutting edge does its share of the work. The exact amount of clearance cannot be given; by observing taps that work all right, one can acquaint himself with the proper amount.

In order that the workman may readily observe when he is approaching the cutting edge when filing for clearance, various methods are used. Some mechanics color the surface with Prussian blue; while others color it with the "copper solution" used in most shops for coloring surfaces where lines are to be drawn. To make this solution, dissolve in a bottle of water all the crystals of blue vitriol the water will take up; to this add a small amount of sulphuric acid—about one teaspoonful to three or four ounces of the solution. Another method consists in heating the tool over a slow fire until it assumes a distinct straw, or a blue color.

In shops where there is no emery wheel the face of the cutting edge and the back of the land are filed. The face must be filed in order to remove any burrs that may have been thrown into the spaces between the teeth when cutting the grooves, and to give the cutting edges keenness. The back of the land is filed to remove roughness incidental to cutting the grooves, so the chips will not cling to this surface.

Many mechanics consider it good practice to give all taps clearance between the teeth to relieve friction; but in the case of hand taps this does not appear necessary, especially if they are not larger than one inch diameter. However, if it is considered advisable to relieve taps in this manner, it may be accomplished by using a *sharp cornered* three cornered file. Commence at the heel of the tooth and file toward the cutting edge, not filing quite to the edge.

Hardening Taps.

Probably no one tool used in machine shops gives more cause for worry when being hardened than a tap. And probably few mechanics realize the very large proportion of taps hardened that are thereby rendered unfit for use. As previously stated a screw should fit perfectly in a tapped hole for its *entire* length, yet if the tap stretches, or elongates, when hardened, the hole tapped with it must of necessity be of a *wrong* lead.

Taps are often unevenly heated and crooked when plunged in the bath, and in this condition they are unfit for use. But under ordinary circumstances they may be straightened by the method described for "straightening counterbores" in our last article.

As the teeth of taps are slender, and absorb heat much more rapidly than the balance of the piece, it is not safe to heat them in an open fire unless they are placed in a piece of gas pipe, or tube, which removes them from the direct action of the fire and the blast. The taps should be turned occasionally, in order that the heat may be uniform throughout the piece. When dipped in the bath the tap should be held in as nearly a vertical position as possible. The bath, which should be either clear water or brine, should not be very cold; lukewarm baths give best results when small pieces are hardened.

While careful heating and low heats will reduce the tendency of elongation, or contraction of pitch, it will not remove it altogether; and if we wish to maintain the original pitch and diametrical measurements we should resort to the method known as "pack hardening."

We will give a description of this method in our next article, in which the subject of taps will be concluded.

SOME PRACTICAL POINTS IN MACHINE DESIGNS.

W. S. LEONARD.

The first requirement in a new machine is that it shall accomplish in a satisfactory manner the particular purpose for which it is designed; but collateral with this, and ever present in the mind of the experienced designer is that other problem of "constructional economy." Let A and B set out to design a machine for a certain work, and let it be understood that each is to rely on his own resources as to the means and devices to be employed, without knowing what the other is doing. Under these circumstances it is quite possible that B's machine may cost 25 to 50 per cent. more than A's, and yet not be any better for the purpose for which it was designed. Both machines may do the work equally well, but B's machine cannot be sold in competition with A's. B's machine is, therefore, a failure from a commercial standpoint.

If we inquire into the qualities to be striven for as affecting the constructional cost of a machine, we shall find that one of the prime considerations is simplicity. This means first, that the machine shall be easy to understand and operate. Some machines are necessarily so intricate as to require that a mechanic be sent from the factory to set them up and give instruction in operating them. But the experienced designer will endeavor to obviate such intricacy whenever it is possible to do so.

Simplicity means, secondly, that there is no unnecessary multiplication of parts. If two elements are used where one would do the same work, this would clearly be a violation of constructional economy. Every gear, every lever and every cam must be essential to the successful operation of the machine, and the designer's task is not complete as long as there is a reasonable doubt in this direction.

Constructional economy is also violated when a machine is unnecessarily difficult to assemble and to get apart for repairs. In building a new machine considerable experimenting is usually required before it is perfected. This necessitates taking out some of the parts a great many times to make alterations and adjustments. If a large portion of the machine must be disconnected to get at one part, too much time and labor is consumed. In the same way costly delays will sometimes be occasioned in making comparatively slight repairs or adjustments. If the designer would steer clear of these difficulties he must put himself in the places of the machinist and future operator, and,as it were, put together and take apart every device in the machine. In so doing he may find it expedient to make cap boxes in some places where there would otherwise have been solid bearings; and in certain lines of machines—printing presses for instance—he may make important modifications of the main frame work in order to make more easily accessible such parts as require frequent attention.

Constructional economy requires that all parts of the mechanism be of such shape as to admit of being machined with ordinary shop appliances. It would be an unpardonable error, for instance, to use some special form of toothed gear when further study would have demonstrated the feasibility of using the standard shape. So, also, all kinds of irregular and untried devices would be objectionable when mechanism known to be right could be made to serve the same purpose. In looking over the models at the patent office one will sometimes find machines which are, indeed, "fearfully and wonderfully made." But many of these machines never got beyond the model stage, and doubtless some that did come into practical use were remodeled to such an extent as to scarcely resemble the original.

Another matter which adds to constructional expense is the unnecessary multiplication of sizes. Take, for instance, a shaft or spindle three feet long and 4 inches largest diameter. If practicable to make this shaft with four shoulders and diameters it would be bad designing to make it with six. It takes time to turn and gage these extra diameters and lengths between shoulders, and if this be repeated on a number of shafts in a machine the additional expense is considerable. In designing such work, or, indeed, any work where standard gages could be used, it is important not only to avoid multiplying sizes, but also to have in mind the sizes in which gages are made, and as far as practicable conform to these sizes.

Taper Fits versus "Straight" Fits.

Speaking generally, designers use taper fits only in special cases; but occasionally we meet one who insists that "the taper fit is the only fit." A gentleman of this persuasion was for a short time superintendent for a concern with which the writer was employed as head draftsman. He began his work by having all drawings for gears, etc., made for taper fits, and held his position just long enough to get everybody in the shop into some other kind of fits. The draftsman was compelled to go against his judgment, the shop was compelled to make a line of taper reamers and taper gages, and it required greater skill in the shop to do the work. If there are two gears on taper fits on a shaft, and the workman makes these tapers in such a way that the gears are, say ⅛ inch too close together, that shaft is spoiled. On straight fits the gears could be moved apart without materially disturbing the fit. As intimated, the superintendent was with the company but a short time. No sooner had he left than the chief draftsman went back to straight fits, when the expensive gages and taper reamers were laid away to rest.

The experienced designer is careful to provide against cooling strains in castings. Brackets, pulleys and all kinds of frame work are likely to have light ribs or arms joined to heavy bosses. In such places strength as well as looks demands that the light member be connected to the heavy member by liberal fillets. If the fillets are omitted the unequal cooling at these places may cause serious stresses in the casting. By uncovering the heavy parts first the molder may partly overcome this difficulty, but the designer should not leave too much to the molder. Important castings have been known to break by a slight jar while being carted from foundry to machine shop.

Tool strains must also be looked after. Take, for example, an 18-inch gear of 16 pitch and having six arms, and assume that it is to run at a high speed with but slight pressure—merely to transmit motion. Under such circumstances an inexperienced designer might make the rim so frail as to necessitate running the milling cutter through the teeth twice to keep from springing the gear by one heavy cut. Otherwise the gear would not be round, and at a high speed it would be noisy. Sufficient metal to support the rim against the pressure of the milling cutter would be much cheaper than passing the cutter through the second time. For similar reasons a long rod or screw would sometimes be made heavier than the operating duty might require.

The range and capacity of the turret lathe has been greatly extended within the last 20 years; and it is generally understood that many kinds of short steel pieces can be machined much cheaper in the turret lathe than in the common engine lathe. Such work is usually turned from the bar without any forging, and to facilitate this, any shoulders or collars that may be required on such work should be made with minimum diameters. This saves not only time in machining, but also saves material. The draftsman who fails to appreciate the economy of the turret machine, and of designing with special reference to turret methods is certainly not up-to-date in his profession. Within the last 10 or 15 years a modified design of turret machine has come into use. This tool is adapted to a large class of work which may be termed "chuck work"—gear blanks, small pulleys, etc. The several internal diameters of a stepped cone pulley may, by the use of a suitable cutter bar and cutters, be turned in one operation in such a machine.

Constructional economy may often be materially enhanced by designing machine parts with reference to convenient adjustment of same on lathe, planer or other tool. A casting may be of such shape as to be almost unmanageable in the lathe chuck, when the addition of four small lugs to receive the thrust of chuck jaws would entirely obviate the difficulty. This principle is also often applied in connection with planer work, and in various other ways; and in most cases the lugs or projections are in no way objectionable in the finished detail. If they are objectionable it is but little trouble to cut them off. It is sometimes practicable to make slight modifications which greatly facilitate machining a casting, and which are not detrimental to the machine of which the casting is a part. In the case of a printing press, or other machine having two side-frame castings. It it desirable to have all planing surfaces on the inner side of each casting in the same plane. In some cases the planing bosses on the outer sides also may be in even planes. It is very easy to bed such a casting on the planer table, and when planed the two castings may be bolted together and opposite holes accurately and quickly drilled and reamed. It will be obvious to the machinist that these castings would be much more difficult to machine if made with bosses and planing surfaces of varying heights. When extra long bearings, which project beyond the common planing line, are needed, it is frequently expedient to use flanged bushings. The bushings are held in holes bored in the frame, by bolts passing through the flanges. The writer has designed such bushings large enough to allow a shaft with several small gears to be passed through the hole in side frame castings without removing the gears. With such a design the bushing has one of the advantages of the cap-box. It also possesses one advantage that is lacking in the cap-box; that is, it enables the operator to duplicate a worn-out bearing very cheaply, and without disturbing the original alignment of the shaft.

The importance of providing the raised surfaces above-mentioned, and the height of the surfaces above the rough line of the frame, are not always understood by the beginner. For the information of the latter it may be explained that it is much cheaper to machine the limited area where details are bolted on than to machine the broad surface of the frame. As to the amount, the minimum height could be taken as ⅛-inch for a frame four feet long and less, with an addition of 1-16-inch for every additional four feet. This does not include the stock to be planed off. Generally the patternmaker can be trusted to provide the proper stock for machining; but an allowance of ⅛-inch for the first four feet of length, and 1-32-inch for each additional four feet would be about right in most lines of work. The rough height would then be ¼-inch for 4 feet, 11-32-inch for 8 feet, and 7-16-inch for 12 feet. In the proportions here given it is assumed that the width of the frame is not greater than the length, or that the allowances apply to the greatest dimensions. The reasons for allowing more on a long frame than a short one are that the pattern, or mold, or both, are more likely to be warped or otherwise put out of shape in the case of the longer frame. It may be well to repeat that the finished heights of the planed surfaces or bosses are the minimum as given above, and nothing is said against making them as much higher as circumstances may require.

Because of irregularities in shrinkage, and slight errors in the pattern, bosses usually need to be made from 1-6 to ¼ inch larger in diameter than the corresponding boss or hub of the adjoining detail. Here again we make greater allowance on long frames than short ones. The eccentricity of the bosses may be corrected by chipping or by "trueing up" with cutter bar and cutter in the drill press. Warpage and other irregularities have to be taken into account, also, in making allowance for the clearance of moving parts in the machine. This is a very simple proposition, but it is nevertheless often overlooked. The same habit of mind which leads to this error will cause the designer to locate bolt holes so close to the web in a frame, as to necessitate chipping the casting to make room for the bolt head and wrench. The drawing looks all right, but one can never depend upon rough frame lines being exactly like the drawing. Neither can cored holes be expected to be like the drawing. The back gear quill of a lathe is commonly recessed out in the center, leaving a bearing at each end for the eccentric shaft. This is done to save the needless expense of boring the whole length. But if some allowance is not made for the deflection or displacement of the core, the machine shop may have to contend with the very difficult operation of machining the recess as well as the bearings on the two ends. This would be more expensive than if the core had been made of one diameter the whole length.

In a job of this character the recess core should be at least ¼ inch larger than the shaft—⅜ inch would be safer.

In planning a series of machines much needless expense may be avoided by designing many of the details with reference to their use in two or more machines of the series. While this expedient tends to economy in all the processes of manufacture, the greatest saving will generally be in the machine shop. Here fewer special fixtures, jigs, gages, etc., will be required, and larger quantities of the duplicate pieces may be made without overstocking. Experience and good judgment, however, are of great importance in this connection. In order to make certain parts answer for a small and large machine, we sometimes have to make them somewhat heavier than necessary for the small machine in order to make them sufficiently strong for the larger one; and if this matter be carried too far we will have badly-proportioned machines. In large frame-work we may often make one pattern answer for two machines by merely changing such loose parts as bosses, lugs, etc.

The question of machine design involves so many practical considerations that in writing an article of this character it is difficult to determine where to leave off. It may be well to conclude, however, with a bit of advice to the young designer and technical graduate, for whom this article is more particularly intended. However optimistic you may feel respecting a new design, do not be extravagant in estimating the performance of the machine. Every new machine is to some extent an experiment. It may accomplish all you predict; it is more likely to do less. Some very trifling and unlooked-for causes may sometimes seriously interfere with the production of a machine. A very fine printing press, built by an Eastern concern, did an excellent quality of work; but the quantity was disappointing, because the mechanism would not, after all the exacting requirements as to printing were done, deliver the sheets in a uniform manner. About one sheet in 20 or 30 would crumple in such a way as to disarrange the following sheets until the press was stopped, and the disordered sheets removed. The difficulty was entirely overcome by running the press at a slower speed, but the output was less than estimated. In other cases, machines which were satisfactory as to the quality and quantity of the output have been condemned because of their being too noisy in operation. Expensive alterations are sometimes required to remedy evils which, to the inexperienced, seem of slight importance, and which are very easily overlooked in designing a new machine.

* * *

A. S. M. E. MEETING IN CHICAGO, MAY 31.

The Chicago meeting of the American Society of Mechanical Engineers is to be a joint meeting of the American and British societies of Mechanical Engineers, and will begin on May 31. The purpose of many of the visiting members will be not only the meeting and the Exposition in St. Louis, but the privilege which the Americans will give them for a study of our establishments and methods. The Council of our Society (American) desires to facilitate and further the purpose of the visiting engineers in each city in which their interests may center. It is proposed that during the continuance of the British visit, in the months of May and June, there should be organized in each city a Bureau of Information in the office of one of the A. S. M. E. members in that city.

The Secretary of the American Society will accredit the visiting British engineer to the local office, by a letter, and in this local office the visitor shall be instructed as to the establishments he wants to see, how to reach them and for whom he is to ask and present his credentials. It is believed that by this system of special centers, with definite and exact knowledge in each, the purpose of the visitors can be best secured, and with the least amount of apparatus and equipment to bring about the result.

The American members in each city are requested, therefore, to consult with the other members, by telephoning or otherwise, for selecting the committee and securing the address of its executive, who shall be willing to serve the convenience of the visiting members and the purpose of the Society in effective hospitality. This request does not apply to members resident in New York City, Chicago, or St. Louis, but to every other city outside of the three mentioned.

It is expected that no expense should be incurred in the conduct of this plan, but only the rendering of personal service in the way of advice.

If the members will co-operate by communicating with each other as soon as possible, and settling on their committee and the central office to which the Secretary may direct visitors, the purpose of the plan will be most effectively carried out. The visiting members from England should be early advised as to details of this plan, and before leaving home.

The Secretary's office will be asked to guide the visitors to the places in the United States where they can best see the processes in which they are interested. Our members are requested to indicate to the Secretary, therefore, those industrial establishments in their cities where such matters may be studied and where visitors will be welcomed. The Secretary's office seeks to extend its own knowledge by getting the advice of all the members. It will be convenient for this purpose if the headquarters of the Society in New York can be supplied with the catalogues of the various concerns represented in the membership, and of interest in their city or town outside of the membership—such trade catalogues as will be serviceable to the British visitors that they may be made available to them by indexing and in other ways.

It will also be of great use to the visitors if the Secretary can give to them a suggestion of a hotel in each American city at which they will feel at home.

A Committee on Meetings has been appointed to secure papers of importance and interest for publication in the transactions of the Society and to be read at its meetings. A blank has been prepared showing the line of thought of the committee, the topics being grouped under various headings. This blank will be supplied to any of the members who have something to contribute or who can suggest the name of a possible contributor on some timely subject. Address all communications to Secretary A. S. M. E., 12 W. 31st St., New York.

* * *

UNIVERSAL TECHNICAL DICTIONARY.

The Technolexicon of the Society of German Engineers, or universal technical dictionary for translation purposes, in English, German, and French, the compilation of which was begun in 1901 under the auspices of the Society of German Engineers, has received help up to the present time from 363 technical societies at home and abroad; 51 of these are English, American, South African, etc., 274 German, Austrian, and German-Swiss, and 38 French, Belgian, and French-Swiss societies. Of firms and individual collaborators 2,573 have promised contributions. The excerption of texts in one, two or three languages (handbooks, pamphlets, business letters, catalogues, price lists, etc.) and of the existing dictionaries has yielded 1,920,000 word-cards so far. To these will be added within the next two years the hundred thousands of word-cards that will form the result of the original contributions—those already sent in and those still expected—of the 2,573 collaborators at home and abroad, when the editors in Berlin have finished them for the press. Specially made handy note-books had been placed at the disposal of the collaborators to write their collections in, of which 317 have come in filled so far. All the outstanding contributions will be called in by Easter of this year, 1904. The collaborators are therefore requested to close their note-books or other contributions—unless a later term has been especially arranged with the Editor-in-Chief—by the end of March and to forward them to the address given below. As the printing of the Technolexicon is to begin in the middle of 1906, delayed contributions can be made use of in exceptional cases only, up to that time. Further information can be had by addressing: Technolexicon, Dr. Hubert Jansen, Berlin (N.W. 7), Dorotheenstrasse 49.

* * *

The temperature of the flame of a kerosene lamp is about 2,800 degrees F.; of an arc lamp, 5,400 degrees; and of the sun 9,000 degrees (estimated).

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Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

CHICAGO—1462 Monadnock Block. BOSTON—620 Atlantic Ave.

LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1904.

NET CIRCULATION FOR MARCH, 1904,—23,855 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

REGARDING THE INDICATOR.

In the recent issue of a contemporary were shown two outside-spring steam engine indicators that have been placed on the market by prominent American firms, both instruments having the usual coiled springs, but which are placed above the cylinder on an extension of the piston rod. The added length of the piston rod and general change in design necessitated a proportional increase in the weight of the reciprocating parts, and the interesting thing about the indicators is that their designers adopted exactly opposite methods to compensate for this increase in weight. The usual area of an indicator piston is half a square inch, and the stiffness of spring corresponds to the total steam pressure upon a piston of this area. In one of the new indicators, however, the area of the piston is *increased* to one square inch, in order to give a greater force of steam to operate the heavier parts, and the spring is made proportionally heavier; while in the other the area of piston is *reduced* to one-quarter inch, enabling the piston and other parts to be proportionally lighter, their total weight being, probably, about the same as in the old style indicator with its half-inch piston. Now both systems of construction cannot be right, although both are probably right enough when it cames to practice. One can pay his money and take his choice. This is a good illustration of the tendency of men working along independent lines to go ahead in opposite directions, and it behooves us to consider, when we are positive we are right and the other fellow wrong, that he may be as nearly right as we are, after all.

In regard to outside-spring indicators, wherein are they better or more accurate than the old style, with the spring located within the cylinder? It is easier to change the spring, no doubt, when it is situated outside the cylinder, which is convenient; but does the outside spring produce as accurate a diagram, after all? The inclosed indicator spring does not come in contact with steam at a temperature much, if any, greater than that corresponding to atmospheric pressure, or 212 degrees. Prof. Carpenter, in an investigation of the subject, came to the conclusion that the steam escaping past the indicator piston under atmospheric pressure might be superheated a slight amount, and places the temperature of the steam surrounding the spring at 220 degrees, which temperature would be very nearly constant under all conditions. When Mr. Chas. T. Porter began to manufacture indicators, he found that a spring at 212 degrees was one pound in 40 weaker than when at the normal temperature of a room, or that a raise of about 150 degrees would affect the spring one pound in 40. This being the case, the difference in temperatures of engine rooms, which might easily be 40 or 50 degrees, would have an unfavorable effect on the outside-spring indicator, while the inside-spring indicator would always be subjected to very nearly the same degree of heat, which, if properly allowed for in calibrating the spring, ought not to produce variable results.

When the indicator was introduced by Watt, and a few favored ones discovered its great value, the most secretive methods were adopted by those who had been let into its secret. It is related that an engineer once visited an old water works plant at Moscow, Russia, where a Boulton and Watt engine was in operation, and in the examination of the relic he found near the end of the walking beam what proved to be a movable cover, made in such a manner that its presence could not easily be detected. After cover was removed, however, a recess was disclosed in which was concealed an ancient Watt indicator, showing that it had been looked upon as sort of a trade secret. Undoubtedly, however, the indicator has since filled a greater place in the education of mechanical men than any other instrument of the past century. It has been the aim of every stationary engineer to own one and study the lessons of the indicator diagram. We realize with somewhat of a pang, therefore, that wherever the steam turbine is now installed the indicator must be put upon the shelf as a back number, for there is no such thing as the indicated horse power of a steam turbine. It is not needed to understand the action of the turbine, which requires instead the study of the flow of steam through the intricate passages of the wheel and the losses from leakage and friction —questions that are more complex and less easy of solution than most problems connected with the reciprocating steam engine.

* * *

WHERE INTERCHANGEABILITY PAYS.

If we can believe one item of the meager war news received from the Far East, the reason the Russian forts at Vladivostock did not return the fire of the Japanese war vessels during the attack of March 6, was that the shells supplied by the Russian war department were two millimeters (0.078 inch) too large for the bore of the Vladivostock guns. It is difficult to understand why guns of large caliber were built with so little difference in bore and the natural inference is that the difference is one due to slipshop methods of measurement and keeping records. It matters little whether measures are expressed in inches, millimeters or duimes, but it does matter greatly if 10 duimes at St. Petersburg mean something else at Vladivostock.

We do not need to go abroad, however, to discover the evils of many standards or rather of no standards at all. The recent big fires in Baltimore and Rochester called renewed attention to the great diversity of hose couplings and hydrant connections. Almost every large city is a law unto itself in this respect, each having a standard of its own, and in the event of a big fire that requires outside assistance there is much trouble, if not actual impossibility of making connections between the fire engines and hydrants. It seems that a national hydrant nozzle should be adopted by all American cities and towns—the matter of hose connections is not so vital, but this matter should also receive attention. Speaking of hydrant nozzles being made standard, why should not engine lathes of the same swing be made with the same size nose and thread so that all chucks and faceplates for one size of lathe will be interchangeable? This is the condition existing in one New York machine shop that we know of and the convenience of the system is well worth the trouble of making all the lathe noses to a common standard. When new lathes are ordered for this shop the size of the spindle nose is specified in the order.

MACHINE SHOP EQUIPMENT.

The series of articles by Mr. Oscar E. Perrigo, upon machine shop equipment, closes with this number. We believe this has proven to be one of the most interesting and valuable series published, inasmuch as Mr. Perrigo has described in detail the various devices that enter into the equipment of a machine plant and has based his descriptions not only upon the result of his own experience, but upon information secured through extended investigation. One who has had a plant to equip realizes how much time is required to decide upon some of the apparently trivial features, and these have not been overlooked, as has so often been done by more superficial writers.

As supplementary to his closing article, Mr. Perrigo writes that the series should hardly close without referring briefly to facilities for providing lunches for the employees. "In many of the modern and up-to-date manufacturing plants," he says, "there has been considerable effort made, and considerable expense incurred, to provide for the employees such useful accommodations as dining rooms, cook kitchens and the necessary accessories which go to make such arrangements complete and serviceable.

"There have also been provided assembly, lecture and reading rooms, and similar conveniences, not directly connected with the strictly manufacturing operations. All these matters are very commendable, and show not only a proper spirit of liberality on the part of the owners of the plant, but a deep interest in the individual welfare and comfort of the employees, as well as in their educational and intellectual advancement.

"In the design, construction and equipment of a plant, however, we have endeavored to confine everything as closely as possible to the actual necessities of manufacturing facilities, and while endeavoring to adopt all proper conveniences for successful manufacturing, it has been the aim to avoid the question of such conveniences as might be termed luxuries, purely from reasons of economy. These facilities and improvements will follow quite naturally as the plant grows older, without special suggestions to that end, and ofttimes quite as frequently as the conservative owners of the plant will want to pay for them."

* * *

NEW VENTURES OF THE ALLIS-CHALMERS COMPANY.

When the General Electric Company definitely decided to enter the steam turbine field, it was to be expected that the Allis-Chalmers Co. with their new West Milwaukee shops, would make some counter move. The Westinghouse companies were preparing to supply generating units complete with both the electric generator and the steam engine or turbine for driving it. The Allis Co. therefore must look for a large part of their business in the supply of reciprocating engines for driving apparatus built by the General Electric Co.; and when the latter decided to advocate the turbine, and built a large plant for building much of the steam machinery that they would require, the Allis-Chalmers Co. were forced to take such action as would place them on an entirely independent basis.

It has previously been announced that the Allis-Chalmers Co. had acquired the American patents, and were the sole licensees for the western hemisphere, of the Nurnberg gas engines, built by the Nurnberg Machinery Co., Nurnberg, Germany, which they were prepared to supply in sizes up to 6,000 horse power. They have also become the licensees of the hydraulic machinery of Escher-Wyss & Co., Zurich, Switzerland, who have designed upward of 85,000 horse power installed at the Niagara Falls plant of the Cataract Construction Co. While these two acquisitions will probably greatly increase the production of power-generating apparatus by the Allis-Chalmers Co., the move they have resorted to to make themselves independent of the two electrical companies is even more important. They have become associated with, and form part of, the Turbine Advisory Syndicate of England, comprising the Yarrow Shipbuilding Co., the Tweedie (Vulcan) Shipbuilding Co., Willans & Robinson, and Mr. Fullager, formerly chief engineer of the Parsons Steam Turbine Co., of England. They will shortly prepare to build steam turbines of the horizontal Parsons type, in units up to 10,000 K. W. Mr. Robert A. McKee, formerly an engineer with the Westinghouse Machine Co., is the mechanical engineer of the steam turbine department of the Allis-Chalmers Co. Arrangements have also been made for the manufacture of electrical machinery and this department will be in charge of Mr. John F. Kelly, formerly of the Stanley Electric Co., and Mr. Wm. Stanley, Jr., who will act in a consulting capacity.

These developments, which have come in such rapid succession, bid fair to be more far-reaching in their results than any event in their field since the Westinghouse Machine Co. began to manufacture prime movers for large generating plants a few years ago. It was estimated that it would take the Allis-Chalmers Co. something like two years to secure the equipment, designs, and patterns for a line of heavy electrical machinery, but there has been another occurrence in the rapid succession of events. It appears that the Bullock Electric Mfg. Co., of Cincinnati, which is a New Jersey corporation, has been leased by a new Bullock Company, organized under the laws of Ohio. The new corporation is one in which the Allis-Chalmers Co. are financially interested as principal owners. Inasmuch as the Bullock Electric Mfg. Co. have added to their standard line of direct-current motors and generators rotary converters and some of the largest types of alternating-current machinery, the Allis-Chalmers Co. are therefore able to fill orders at once ranging throughout the entire field of electrical machinery, and are in a position to supply reciprocating steam engines, gas engines, and steam or water turbines for prime movers.

In this connection it is interesting to note that when Mr. Reynolds, formerly chief engineer of the Reynolds-Corliss Engine Co., first came into engineering control of the old Milwaukee works, he predicted direct-connected units such as are now being used, and advocated the manufacture of electrical and steam apparatus by that company, as soon as the state of the art should be such that this could be accomplished. We thus see how the dreams of this famous engineer have come to pass, but on a more magnificent scale than he would have dared to predict.

* * *

OTHER TURBINE DEVELOPMENTS.

Another interesting development is the formation of the United Steam Turbine Co., of Berlin, for the exploitation in Austria-Hungary, Russia, and several of the smaller European countries, of important American and foreign patents. The American patents are those controlled by the General Electric Co.'s interests in this country, and those of the Allegemeine Elektricitats Gesellschaft, of Berlin, Germany, and of the Union Electric Co., also of Berlin. The new United Steam Turbine Co. control the patents on the Riedler-Stumpf steam turbine, illustrated in the February number of MACHINERY, as well as the Curtis steam turbine patents—which places them in a position to exploit these two types of turbines. Furthermore, there has been a transaction between the Allegemeine Elektricitats Gesellschaft and Brown, Boveri & Co., Winterthur, Switzerland, by which the turbine as developed by the former company will be introduced into a wider field in other sections of Europe. In this country it is generally known that the Hooven, Owens & Rentschler Co., Hamilton, O., manufacturers of the Hamilton-Corliss engine, are at work on a steam turbine of large size which, if successful, will be exhibited at St. Louis. This turbine is understood to be similar in principle to the Rateau though, as far as we can learn, it is not manufactured under an arrangement made with Messrs. Sautter, Harle & Co., of Paris, France, the original manufacturers of this type.

* * *

A cement that makes water-tight joints is made of sulphur and sand mixed in the proportions of 1 and 1 or 5 to 7, sand being the larger constituent. The mixture melts at 250 degrees F. and is poured like lead. It is much stronger than pure sulphur, the strength of pure sulphur being only about 100 pounds per square inch, while the sulphur-sand mixture has a tensile strength of about 650 pounds per square inch. The *Engineering Record* says it is unaffected by frost or heat up to the melting point, or by acid and alkaline liquors.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

After thirty years of intermittent labor the south bore of the Hudson River tunnel, connecting Fourteenth St., Jersey City, with Morton St., New York, was completed March 11—that is, the last headings were coupled but there remains much work to do on the approaches. The north bore is still to be completed and it is expected that both bores will be in working order about April, 1905.

Mr. James P. Lee, the inventor of the Lee magazine rifle, known variously as the Lee-Enfield, Lee-Metford, etc., died recently at New Haven, Conn., at the age of 73. Mr. Lee's inventions were favorably received in England, but he failed to get them adopted by the United States. Mr. Lee, we believe, was the first to use the detachable magazine in which the cartridges are assembled one above the other with a spring beneath all to feed them upward into the breech.

A so-called aluminum soldering process for uniting aluminum to steel or iron was recently described in a German technical publication. The iron pieces are first electroplated with copper and then aluminum in the melted state is poured on. The iron piece, of course, is in a suitable mold and the shape of the aluminum boss is determined by the shape of its portion of the mold. In this manner cast iron or cast steel cylinders may be made with aluminum bosses or other parts perfectly united since the aluminum has a great affinity for the copper when in the molten state at a cherry red temperature.

According to the accounts the experiments on heat transference through boiler plates, which were conducted in Germany some time ago, have demonstrated that the value of stirring or circulating the water increases with the intensity of the agitation, the increase of efficiency being small, of course, as the agitation becomes brisker, but no limit was reached beyond which there was no increase in the heat conductivity. It is suggested that one reason for the superior steaming efficiency of the locomotive boiler is the mechanical agitation to which the water is subjected, since it probably helps to detach the steam bubbles from the surfaces of the tubes and plates.

When the American engineers were building an electric power station in the Mysore territory in southern India they found that something was wrong with the lubrication of the machinery. The oil disappeared. They discovered that a Hindu must, by his religion, take a periodical bath in oil. To him oil is oil. The workmen had drained the bearings for bathing purposes. How to stop the thieving was a puzzling problem until some one solved it. The Hindu does not eat meat, and he will not touch anything that has blood in it. Two or three animals were killed, therefore, and blood was dripped into the bearings. There was no more stealing of oil, however many other things were stolen.—*The World's Work.*

In an address on electrically-driven shops, delivered by Mr. R. L. Warner before the Electrical Engineering Society of Worcester Polytechnic Institute, November 20, 1903, mention was made of the great value of the traveling bridge crane; the great manufacturing plants of the present time would be practically impossible without it. In the same connection he mentions an interesting feature of the use of electro-magnets with the traveling cranes for lifting plates and other iron material. With electro-magnets, used instead of hooks or chains, there is no difficulty in piling plates or shapes on top of each other and very close together. Obviously, with hand labor, there would have to be allowed sufficient room for the men to get around the piles, and, as a matter of fact, all the material would practically have to be stacked on edge.

The round-bottom fire bucket has a rival. The purpose of the round bottom, to prevent the use of the bucket for general purposes, being so easily overcome by making a dent in the bottom to get a flat place, has inspired the cone-shaped bucket. The bottom of the new bucket tapers to nothing and there is no point to set it on, apparently. It is, in fact, a bucket without a bottom. The driver of the mill wagon illustrated how easily the best intentions are frustrated. He wanted to water his team, and used one of these buckets. At the pump there was a box to place the bucket on, and it happened there was a knot hole in the box. The point of the bucket was put in the hole, and it stood up as well as any other old bucket. It is a poor mill man who cannot keep up with the inventors.—*Woodworker.*

"Meteorit" is the somewhat fanciful name given to an aluminum alloy that is much harder than pure aluminum, which is claimed to have all of its good features and to possess several additional ones. Its specific gravity is about the same; it is not affected by acids, the atmosphere or sea-water; it can be cast like cast iron and has eight per cent. greater strength; it can be rolled hot or cold and does not become brittle when hot; it has nearly the conductivity of copper; will keep a high polish and can be electroplated. The *Mechanical Engineer* states the above and says that the new metal is made by W. Rubel, of Germany. We sincerely hope that more will come of this "discovery" than has developed so far from the many other wonderful alloys with which we have been regaled during the last few years.

One of the most interesting features of the new plant now being erected by the B. F. Sturtevant Company at Hyde Park, Mass., is an elaborate testing plate for its engines. With an output of a thousand engines or more per year this is an essential feature of a careful system of manufacture and testing. The plate, or more properly the plates, will be supported upon a series of heavy parallel walls between which steam and exhaust pipes are carried, so that at almost any point in the entire area of the floor, measuring about 30 feet by 60 feet, steam and exhaust connections may be made to any engine. Testing facilities will be provided, and a transfer crane overhead will make it very simple to locate or remove the engines. The same crane will transport them to the packing department, and thence load them directly upon cars which traverse the end of the building.

It is not easy to obtain satisfactory results in the use of cement in cold weather, owing to its failure to set and harden. The crystallization of cement, which occurs in the process of hardening, is retarded by cold and hastened by heat. Taking 60 degrees Fahr. as normal temperature, experiments show that the setting of cement is accelerated by 14 per cent. at 80 degrees and retarded by 114 per cent. at 40 degrees. The most important improvement in the use of cement in recent years is the introduction of ferro-concrete, in which, by embedding suitably shaped iron rods or wires, the tensile strength is increased ten-fold and the ability of the cement structure to resist tensile stresses is made as great as its ability to resist crushing. One of the recent uses of ferro-concrete is for concrete piles, which are practically imperishable and increase in strength with age. They have been employed with great success abroad in ordinary dock work.

The *Electrical Engineer* of London recently published an article by Mr. A. S. Cubitt on electrical speed indicators and gave the history of some unsuccessful attempts in this line. The object of these experiments was to devise an instrument that will reliably indicate at any moment the speed in miles per hour at which electric street cars are running. A successful and simple device of this character should be very valuable to motormen—and the public. We already have the Boyer speed indicator for locomotives, but this is somewhat too expensive for street car use. Another speed indicator which should be popular with machine shops but which so far as we know has not yet been invented, is one that can be placed in the tool-post of a lathe or planer and which will indicate the surface speed in feed per minute without the use of a watch or requiring any calculation. Such a device would be the equivalent of the tachometer much used in steam engine tests for indicating the revolutions per minute. The tachometer, however, is entirely too delicate and expensive for machine shop purposes.

The saving of time that is sometimes effected at one stroke by the introduction of a machine into some class of work is something quite wonderful. An example in point is the rotary bevel shear which has come into use in boiler shops for shearing, splitting, beveling and forming the edges of boiler plates. Formerly it was necessary to shape the edges of all flanged parts such as domes, heads, furnace mouths, etc., by the slow and laborious hammer-and-chisel process. With the rotary shear, however, such parts are beveled and shaped in a small fraction of the time required by the hand process. The machine is adapted to work complicated shapes, and the action of the rotary cutters both feeds and cuts the stock. It is said that such machines will trim stock at the rate of from 400 to 500 feet per hour. In railroad shops it has been found, for example, that a door sheet, which required 420 minutes to shape by hand, can be shaped and beveled with the machine in ten minutes. Other characteristic work is done with a proportional saving of time.

One of the consular reports sent by Mr. Murat Halstead, of Birmingham, England, a few months ago in regard to the automobile business, states that one of the novelties of the season is an arrangement of the steering pivots for the forward wheels of a car known as the Weller car, designed to resist the strain on the wheels when rounding corners. The manufacturer's explanation in a card in a motor paper is that the steering pivots are inclined forwardly as well as outwardly. The action of the steering wheels on a curve is complex, the effect on the two wheels not being the same. When rounding a curve to the right the outer or left steering wheel is brought up from the normal inclination of a wheel fixed to a regular form of pivot or axle when turning a curve to the vertical; but the inner wheel is still further inclined, thus throwing the weight of the vehicle inward upon its wheel base and putting, he believes, the wheels in the most advantageous position possible to withstand the stress produced by centrifugal force when rounding curves. The leaning action of the wheels toward the center of the curves is proportional to the radius of the steering circle and the object of the outward inclination of the pivots is to obviate the risk of strain on the steering gear when overriding obstacles.

If it is not practicable to accomplish a result mechanically in one way it may often be done in another way equally as good and with great simplicity. The history of labor-saving appliances is full of examples. Not many machines duplicate the motions of the human hand, because it is possible to accomplish the same result in a far simpler manner. A case in point is a machine for opening letters that was recently patented by Mr. Henry C. Zenke, New York. A machine that would insert a knife under the flap of the envelope and rip it open, would be entirely too costly and complicated for ordinary use and it is quite doubtful if it could be made operative. This machine, however, simply *saws* the edges off the envelopes, thereby releasing the contents. The saw is mounted on the shaft of an electric motor and is of the end-cutting type, being made in the shape of a hollow cylinder or tube with the teeth on the end. In other words, the saw is of the same type used by coopers for sawing out staves. The envelopes are gathered together in a bunch with the top edges even and in this position they are passed before the saw. The saw is protected by a shield carrying a ledge on which the envelopes are laid and above which is a narrow slot where the saw is exposed.

Consular Report No. 1,896 says that mine owners have predicted the entire exhaustion of the steam-coal beds in England within a generation. This possibility is deprived of some of its terror by the announcement that an electrical process has been discovered whereby peat can be converted into hard, smokeless steam coal which, while occupying less room in a ship's bunkers, will, it is claimed, hold its own against the best Welsh coal. According to a description of the process, the peat from the bog is placed in rotary cylinders, and after the water has been expelled by pressure, electrodes with electric wires attached are inserted, and the mass becomes the medium of the completion of the circuit. Heat is generated by the resistance offered, and this in turn gives the objective result sought, namely, a perfectly disintegrated or pulverized material which separates freely into particles and has suffered loss of none of the properties primarily contained in the peat. Kneading and teasing operations serve to bring the mass into a plastic condition, so that it contracts into any shape or size desired. The cost is said to be much below that of coal at the pit's mouth. An initial plant is to be erected immediately in Ireland, where one-seventh of the surface of the land consists of peat bog.

Thawing frozen water pipes by electricity is a winter industry that was developed two or three years ago in northern cities having a rigorous climate, but during the past "old-fashioned" winter, it has assumed considerable importance in that part of the country generally experiencing mild winters. Water service pipes are rarely buried in the earth to a depth exceeding four feet, so when we consider that the ground froze to a depth of five feet or more in the vicinity of New York City, it is not to be wondered at that frozen water pipes were the rule rather than a novelty. The electric thawing process is rapid and one that requires little labor, there being little excavating required—generally none. The usual plan followed is to connect one terminal to the water pipe of the house having the frozen connection and the other terminal to the service pipe in the cellar of an adjacent house. A few moment's application of the current thaws the layer of ice next to the pipe, which allows the water to flow, the taps being left open for this purpose, and the flowing water completes the job. A current of low voltage and heavy amperage is required, which makes it necessary to employ "step-down" transformers when taking current from an alternating lighting circuit. Ten minutes is about the average time required for thawing out a system that would require the services of a gang of men for a day if the old method of digging and thawing with a fire was pursued. So much for modern methods.

It is surprising to learn what elaborate instruments are sometimes devised for determining an easily established fact. A valued contemporary shows a detector, measurer and *recorder* of scale formation in the tubes of water-tube steam boilers which is alleged to have received the indorsement of the Franklin Institute to the extent of being awarded the John Scott Legacy medal and premium. The description is accompanied by a somewhat lengthy argument on the advantages of the device and the extreme difficulty (?) not to say impossibility of detecting scale without such a device save by shutting down the boiler. So far as we can see the same applies when this instrument is used. "The instrument consists of a tube serving as a frame having a traverse wheel mounted thereon, which rotates by contact with the inside of the tube to be measured, as it is passed through for the purpose of exploration. This wheel by suitable gearing rotates a disk on which is mounted a chart or dial. A movable arm opposite the traverse wheel is mounted on the frame, which acts as a lever, causing a reciprocating motion of a rod carrying a pen, which rests on the chart, the motion of the pen corresponding to the reciprocating motion of the arm," etc. Of course the vulgar engineer who pokes a tomato can through the tubes to see if they are free from scale or choked, is hopelessly behind the times; he should have one of these valuable instruments and carefully preserve sets of charts for future reference. In fact they might serve as the basis for an exhaustive paper accompanied by diagrams, etc., upon the value of "Daily Scale Records," etc!

The combustion of one pound of coal in a well-designed boiler furnace will evaporate from 8 to 10 pounds of water, which is considered a fair commercial rating. But in the purification of bad water or sea water by distillation the fuel cost of the direct process is practically prohibitive. By using distillers built on the so-called Yaryan multiple-effect system it is possible and practicable, however, to more than quadruple the evaporative power of a pound of coal, or rather to more than quadruple the product of distilled water. The steam from the main boiler is led into what to all purposes is another boiler, and by its condensation it evaporates the water containing impurities, the steam from which passes into another so-called boiler and repeats the operation. The result is that each drum acts both as an evaporator and as a condenser. The successive evaporations are made possible by maintaining a successively decreased pressure in each boiler. A Scottish firm, Mirrlees, Watson & Co., Glasgow, recently built two sextuple-effect distillers for the Egyptian government which yield about 45 pounds of distilled water for each pound of coal. Each plant consists of six horizontal cylinders arranged vertically, one over the other, the total height being something like 39 feet. The pressure in each shell is graduated, being less in each successive effect than in the preceding one, which makes it possible to boil the water in one by absorbing the heat of the steam in the preceding effect. The apparatus, of course, includes steam pumps for maintaining the circulation.

The framework of the Darlington Hotel in New York, a structure designed to be twelve stories high, but erected to the eleventh floor only, suddenly collapsed March 2, causing the death of over twenty persons in the ruins. It was being erected with vertical columns of cast iron, and these are supposed to have been primarily responsible for the disaster, although it would probably be nearer the truth to say that it was caused by the use of poor and inadequate material, defective design and incompetent supervision. It appears that the building laws and regulations had been repeatedly violated and that the upper floors were very heavily loaded with building materials. The flanges of the cast iron columns were found to be, in large part, honeycombed and full of blowholes and the castings as a whole of poor quality. It is also affirmed that the flanges were not machined and that the bolt holes were cored instead of being drilled. The wreck is one that will cast additional suspicion on the use of cast iron members in tall buildings, and it is conservative to assert that the building laws should be amended so as to prevent their use except in such generous proportions as to make them of little or no advantage over rolled steel. Cast iron is too uncertain at best for close engineering calculations, but rolled steel is a material very uniform in the matters of section thickness and strengths. Again cast iron columns give a building very little lateral strength to resist wind pressure, which becomes a serious factor in tall buildings, but with steel frames the use of gusset stays provides for lateral strength admirably.

The New York Rapid Transit Subway was started in May, 1900, and it is expected that it will be opened to the public next June. The work has been a colossal undertaking, not so much on account of the vast quantities of earth and rock to be removed, but because of conducting it in a crowded city through streets carrying a great volume of traffic and beside tall buildings whose foundations were threatened by the excavations. In addition there were the multitude of water pipes, sewers, gas mains, electric conduits and pneumatic tubes with their surface connections, etc., that had to be displaced bodily without interruption of their service or with as little as possible. This work alone is said to have cost the contractors fully $3,000,000. For the greater part of the route the tunnel was carried on by the "cut-and-cover" plan; that is, it was dug as a ditch and covered over by a roof carried by steel structural work. The tunnel is finished in white glazed brick or tile, and the stations are the same with colored trimmings, the color scheme being varied for each station. The white interior makes the lighting power of the incandescent electric lamps considerably greater than if any other color had been adopted. The lighting circuit is entirely independent of the power circuit, so that any break in the latter will not interfere with the lights, the latter being an accident that would do more to precipitate a panic than almost anything else that could happen. It was the failure of the lights that caused the greater part of the loss of life in the Paris tunnel horror of a few months ago. The lighting system in the Subway besides being independent of the power circuit, is composed of two circuits entirely distinct and having separate sources of supply. One circuit lights the west tracks and the other the east tracks. In the event of one breaking down the other circuit would still light the tunnel so that traffic could proceed.

"Professions are not mines of wealth; those who have embraced them are not paid in proportion to their merits, anomalous as it may seem. Men have grown gray in the services of colleges without receiving more than a very small salary. Be this as it may, the shopman has by no means a poor outlook in comparison with many of the so-called learned professions—lawyers, physicians, and even clergymen. He can command now $3 per day, and much more if he is a skilled man; on piece and contract work he can make "good money," as the saying is. Few professional men make $3 per day in the early years of their careers, and there is nothing in the calling of any workman to debar him from civic or national honors if he seeks them. The only thing which prevents more young American men from taking up trades is the fancied stigma which attaches to a mechanic, so-called, among a certain class—one, by the way, whose verdict is of no importance from any aspect. If I had a life to live over I should devote five years to learning a trade first. I would go into a shop without giving any one a hint as to my intentions later, and would take what came, keeping an open eye and receptive mind for all within my field of vision. After such an experience I would go to a scientific school (if not outlawed by an age limit) and absorb knowledge as a sponge does water. As one benefit from this course, I would have a sound mind in a sound body, enabling me to study hard and to appreciate more readily the teachings of science. I could see exactly where it agreed or conflicted with practice."—*Egbert P. Watson in Engineering Magazine.*

PRESERVATION OF WOOD FROM FIRE AND DECAY.

A paper was read by Mr. Joseph L. Ferrell before the Western Society of Engineers, January 20, 1904, in which he reviewed his celebrated process for preserving wood from fire and decay. The process briefly consists of saturating the wood with a solution of sulphate of alumina under heavy pressure—450 to 600 pounds per square inch. Where structures already built are to be treated, the exterior surfaces are covered with an enamel which successfully resists the attacks of fire for a long time. For the system it is claimed: 1. The elimination of the property of inflammability from wood and other fibrous substances, by impregnation with a permanent non-combustible chemical. 2. The practical plating of wood surfaces with an enamel, all of whose constituents are insoluble and infusible. 3. The permanent protection from decay of all wood by impregnation with a chemical solution. The sulphate of alumina costs about 75 cents per 100 pounds and the strength of the solution is made about 15 degrees Baume hydrometer test. The process costs about $9 per thousand board feet. It preserves wood from the ravages of termites or white ants which are so destructive in tropical countries, and is believed to be an effective check to the teredo, which bores into the piles of wharves. The preservative effect of the sulphate of alumina depends upon its power to coagulate the albuminoids in the wood, thus stopping decay from internal processes and preventing the entrance of external influences to set up decay. The practical value of an effective means of preserving wood from the two destructive elements—decay and fire—makes this process of great interest. Mr. Ferrell has been granted the Elliott-Cresson gold medal by the Franklin Institute.

NOVEL PROPULSION SCHEME FOR BOAT.

The United States Consul at Birmingham, England, says in Consular Report No. 1899 that an English firm is introducing a light and handy explosion motor for boats that is known as the "universal transferable steering propulsor," the invention of a French firm. The great advantage of this steering propulsor is that it can be readily applied to any existing boat, converting the same into a petrol (gasoline) launch, without the necessity of boring a hole through the stern post and supplying a permanent propeller shaft and stuffing box. It can be attached to a boat and removed from same without any modification of the boat itself. Anyone taking this "steering propulsor" to a lake, river, or the seaside may attach it to any boat he finds there that is within its range of power. A rudder is unnnecessary, the boat being steered by varying the angle the axis of the propeller makes with the keel. As the propeller can be completely turned around, a reverse action is given. It is authoritatively stated that a number of these transferable propulsors have been adopted by the navies of France, Russia, and Japan, and that a 12-horsepower propulsor has been successfully applied to a launch, which towed a 300-ton canal barge with a load of 150 tons of sand.

EFFECT OF COMPRESSION ON FINELY-DIVIDED METALS.

The experiments of Professor Hof, of Witten, Westphalia, in determining the effect of compression on finely-divided metals, was briefly reviewed in a recent issue of *Engineering* (London); the results of these experiments are interesting and may possibly prove of practicable value.

Prof. Hof has so far confined his studies to the compression of powdered or finely-divided particles of one and the same elementary or compound substance, and his results are of interest to the engineer as well as to the scientist. He took turnings of steel, copper, bronzes, and chiefly of a white bearing metal which has the composition—83 parts of tin, 11 parts of antimony, and 6 parts of copper. His experiments have, as a rule, been made with about ½ pound of material, which he compresses in a steel cylinder, 2 inches bore, gradually increasing the pressure to 50 tons. With a piston pressure of 10 tons, acting on the circular base of 2 inches diameter, the structure of the turnings still remained distinguishable. But the final pressure of 50 tons produced a perfectly homogeneous block, demonstrating, as the author expresses it, that cohesion is nothing but strongly increased adhesion. Another shallow block, made in a cylinder which had a wider bore below than above, assumed the exact form of the chamber so perfectly that the block could be nickeled without further finishing. This is an important point, and Prof. Hof considers that it may prove profitable to press bushes instead of casting and afterward finishing them. The compressed material is, moreover, denser than the casting. The presence of pores in ordinary white metal indicates that compression must be possible. In the specimens previously alluded to, the density rose from 5.67 to 6.85 and 7.15, the height decreasing from .90 to .74 and .69 inch under the pressures of 10, 30, and 50 tons respectively. In further experiments, the pressure was slowly increased by ten steps of 5 tons, beginning with a pressure of 5 tons. The specimens had in this case a diameter of 1.59 inch. The limit of compressibility was nearly reached when the pressure became equivalent to 25 tons per square inch. When turnings of white metal such as can be bought are melted down, there is always a considerable waste owing to oxidation, and the waste is, of course, much smaller when blocks are fused. Prof. Hof has observed that this difference in the loss by oxidation of the finely-divided mass and of solid blocks almost disappears when the material has been subjected to heavy compression.

ALUMINUM WELDING PROCESS.

Although the uses of aluminum are constantly increasing—also the total consumption—it is, in some ways, an unsatisfactory metal for practical purposes. Its deterioration under the influence of salt water and the lack of a reliable solder have had a serious influence on its use in what otherwise would perhaps have been its largest field—the kitchen. This defect as to being soldered is a curious one. A number of aluminum solders have been compounded that seemed at first to be all that could be desired, but the test of time has invariably proved their insufficiency. While it is possible to solder aluminum, as has been repeatedly demonstrated, the joint is *not permanent*. Only recently, samples of aluminum soldering were submitted to us, which comprised aluminum soldered to aluminum; aluminum soldered to steel; to brass; and to copper. All the samples were firmly united and to one not familiar with the peculiar joint deterioration referred to, they seemed to answer perfectly to the demand for an aluminum solder. But the crucial test is to submit such pieces to a water bath for a few days. They will (as did these and as will all others so far as known) separate under the electrolytic action that is set up. This, of course, makes it impossible to maintain a soldered joint in vessels containing water, and if the joint is subjected to atmospheric influences alone, the parts will separate just the same, only the action is longer delayed.

Welding, however, seems practicable for aluminum rods, tubes and possibly for sheets. The Cowper-Cowles process, which requires no flux and no hammering of the joint, is attracting some attention. The aluminum parts to be welded are held in the desired relation by suitable clamps which can be forced together when the welding heat is attained. The heating is accomplished with an ordinary benzine lamp such as used by plumbers and tinners, or by other convenient means. As soon as the welding heat is reached the clamps are forced together, causing a ring of metal to be expanded around the joint and then the heat is instantly shut off by a screen interposed for the purpose while a spray of water is directed onto the weld to cool it. The ring of metal referred to is largely composed of aluminum oxide and is afterward filed off. Welded aluminum rods show by test an elastic limit of 8,000 to 15,000 pounds per square inch and an ultimate strength of 14,000 to 22,000 pounds. This being true, it appears that the best way of overcoming the aluminum soldering difficulty is simply not to solder but to weld.

FOREIGN WARES IN CHINA.

Century, March, 1904.

"The Chinese peasant is no longer content to burn bean oil; he wants kerosene. In scores of humble Laos homes I saw American lamps costing twenty rupees apiece, and a magistrate proudly showed me a collection of nineteen of these shining articles. The narrow streets of Canton are brilliant with German and American chandeliers, and myriads of private houses throughout the empire are lighted by foreign lamps. The desire of the Asiatic to possess foreign lamps is equaled only by his passion for foreign clocks. The demand for clocks is insatiable. I counted twenty-seven in the private apartments of the Emperor of China, and my wife nineteen in the bedroom of the Empress Dowager, while cheaper ones tick to the delighted wonder of myriads of humbler people. The ambitious Syrian scorns the mud roof of his ancestors, and will be satisfied only with the bright red tiles imported from France."

DANGER OF DEFECTIVE PIPING IN STEAM PLANTS.

Cassier's Magazine, March, 1904, p. 463.

The rupture of a 6-inch steam pipe, which caused considerable loss of life and damage to property, is reviewed by Mr. Francis B. Allen, of the Hartford Steam Boiler Inspection and Insurance Company. A large defective steam pipe is almost as potent a factor for loss of life within the steam plant itself as a defective boiler, its destructiveness being restricted to a lesser area only. The pipe which burst was to all appearances sound, but the accident revealed that the weld was defective for a considerable distance. The pipe had presumably been subjected to the usual hydrostatic test at the mill, and it had been subjected to a hydrostatic test of 150 pounds per square inch shortly before the explosion. If the pipe had been as strong as it should have been with a perfect weld, it would have had a factor of safety of at least twenty at the test pressure, but as it was, it burst with a boiler pressure of only 120 pounds per square inch.

There was no way to identify the mill from which the pipe turned out, the distinguishing marks of the different pipe manufacturers being applied with paint, which is readily rubbed off. Mr. Allen recommends that the manufacturers stamp all pipe so as to indicate the manufacturer as well as the quality of the pipe. As the case now stands the steam piping of a plant is "a weak link in the engineering chain," and so long as unknown conditions prevail as to piping, so long will there be an uncertainty as to its safety.

FLYWHEEL GYROSTATIC EFFECTS AND BROKEN CRANKSHAFTS.

Horseless Age, March 2, 1904, p. 241.

A correspondent makes the rather interesting observation that perhaps the frequent breaking of automobile crank shafts is due to the gyrostatic action of the flywheel in connection with the swaying or rocking motion of the car on uneven roads. No one who has ever made experiments similar to that described in the communication will doubt that there is an enormous force opposed to any change in the plane of a rapidly rotating flywheel. When one of the wheels of the car drops into a depression in the road or passes over an obstruction, the plane of the flywheel must necessarily be displaced, except in so far as the action of the body springs intervenes, and it may happen that the additional strains thus placed on the crank shaft near the flywheel are in the same direction as, and add directly to, the normal working strains. Under these conditions it is really not surprising that crank shafts should occasionally break off close to the flywheel, particularly in single cylinder cars, which have usually very heavy and large diameter flywheels in proportion to the strength of the shaft.

About a year ago it was shown in our columns that the gyrostatic action of the flywheel has a tendency to cause a car to skid, and now this same action is shown to produce excessive strains on the crank shaft, and may cause it to break. It will thus be seen that it is very important to reduce this action as much as possible. Evidently, if the plane of the flywheel is transverse to the length of the car, it will be deflected considerably less when one of the wheels drops into a hole than if the plane of the flywheel were parallel to the length of the car. Consequently any arrangement of the engine by which the plane of the flywheel comes lengthwise of the car is, from this point of view, preferable.

TURBINES AND SUPERHEATED STEAM.

Electrical Review, February 26, 1904, p. 361.

In the opinion of Mr. W. H. Booth the causes for the economy of superheated steam in turbines and reciprocating engines are entirely different. Superheated steam is valuable in the steam turbine because it permits of a large expansion and a large ratio of expansion does not entail the loss that would occur in a reciprocating engine. In the cylinder of the reciprocating engine there is a constant action and reaction in progress between the steam and the metallic surfaces, causing cylinder condensation which increases the steam consumption from 30 to 50 per cent. Superheating the steam reduces this loss to a considerable extent.

It has long been boasted that the steam turbine avoids this very serious loss. Every part of the turbine is at the same temperature as the steam which is passing by it, and the passing steam is always at a uniform temperature. That this is so, subject to some slight limitation, is fairly certain. There is, no doubt, a certain conduction of heat along the shell and along the rotor from the initial toward the exhaust end, but to what extent this changes the temperature of the metals is not clear, for each transverse section of the parts is receiving heat and passing it onward, so that it would seem that the finally exhausted steam is acquiring heat from the last portion of the machine at the expense of heat abstracted from the first or initial end. The inference to be drawn is, that there will be a certain, if small amount, of initial condensation of steam in the first few inches of a turbine of the Parsons type, and that this small amount could be prevented by superheat. But, apart from this, there is no need for further superheat to take care of the steam dryness, for the steam will only lose such heat afterward as becomes converted into work. There is little gain to be secured in the steam turbine after a superheat of 140 degrees F. has been passed and it is still behind the reciprocating engine in economy. This proves that the reciprocating engine owes its economy entirely to the steam tightness of its working parts. It lets no steam escape without doing work, except what escapes by becoming water. The losses of the reciprocating engine when in good order are all of the thermal order. These losses affect the turbine comparatively little. Yet the turbine cannot yet be said to have come up to the performances of the reciprocating engine. There must be a reason for this, and the most obvious reason is leakage, which must, therefore, be enormous; from a quarter to a third of the steam which enters the turbine must escape ineffectively by leakage.

Such being the case, the future progress of the steam turbine must be in the direction of reducing its steam leak losses, for there is no gain further to be expected from superheat after 150 degrees F., or thereabouts, except the fractional and calculable gain shown by the formula $\frac{T - T_1}{T}$. This gain can only be secured by enlarging the machine to take the steam of lighter density and expand it to lower final pressures. A long range of expansion seems to suit the economy of the steam turbine, perhaps because in the long or Parsons forms some of the leakage past the earlier blades is caught up at a later point. But if, as claimed, there are some expansion troubles with turbines of the long variety, it would appear rational on this score to reduce the length to a minimum and endeavor to prevent leakage. Absence of rubbing contacts has been held up as the saving grace of the turbine, and rubbing parts have been held to constitute a fatal bar to any final success of the ordinary piston engine. But there do certainly appear good reasons to suppose that a turbine with actual contact parts so designed as to stop leakage would at once take the lead of any reciprocating engine, and would do so with steam superheated not more than 150 degrees F. The question has been asked: "Is the turbine nearer its limit of economical performance than the reciprocating engine?" With our present lights, we can only reply in the affirmative, but it can also be said that a non-leaking turbine would be *facile princeps* with steam of far less temperatures than its rival.

PACKING OF MACHINERY FOR EXPORT.

Abstract of Paper Contributed by Mr. Paul Roux to the American Chamber of Commerce, Paris.

An American machine has much to pass through between the producing factory and its final arrival at the works of the purchaser; cartage, transportation by rail and by sea, transhipment, loading and unloading, Custom House examination, and, perhaps, storage for considerable periods in French warehouses. Its packing comprises the series of operations which have for object the preservation of the machine in good condition up to the time of final delivery. The care with which these operations are carried out, and combined, may not only largely affect their own cost, but also the expenses of transportation, custom dues, and storage, and these expenses, in the case of machinery exported from the United States to France, may amount to a considerable percentage of the selling price.

Preparation of Machines.

All machine-tools after having been completely assembled, inspected and tested in practical running, should be more or less completely dismounted, before packing. It is impossible to lay down fixed rules in this regard, as the extent to which a tool should be dismounted varies with each machine; or, rather, with each class of machinery. The manufacturer must take into consideration the resistance of the tool and its various parts to rough handling in transportation, and decide upon to what extent it should be dismounted to insure safety. It must be remembered that whilst the packing-case will protect a machine against blows which it may receive when in a normal position, it offers little protection against side or abnormal thrusts resulting from an overhanging position. Great care must therefore be taken to see that no part of a machine is in contact with the sides of the case that is not fully able to withstand the rough handling to which the case may be subjected. The feet of a lathe bed, the base of a shaper, or of a milling machine, may be readily broken by the packing case falling, even lightly, on one of its corners, and without the latter showing any external evidence of the fall.

A most important consideration to be taken into account when dismounting a machine is its volume or cubage when packed for shipment. Marine freights are generally reckoned at so much per ton weight, or per 40 cubic feet, at the option of the ship. The exporter has, therefore, every interest to see that the weight, which cannot, of course, be varied, does not occupy a space greater than 40 cubic feet per ton. Nearly all machines, when not dismounted, make up into packages greatly exceeding 40 cubic feet per ton, and even under the best conditions can rarely be packed in cases equivalent in weight and volume. It may therefore be laid down, as a general rule, that every effort should be made to reduce the volume as much as possible by dismounting all projecting parts which increase the over-all dimensions of the packages. On the other hand, the difficulty of assembling parts requiring accurate adjustment must be taken into account, and the exporter must use his best judgment in deciding at what point the difficulties of setting up the machine will outweigh the economy realized by reducing the volume of the package.

This question of reducing the cubage is worthy of the closest attention of American manufacturers, as the freight from the United States to French ports is extremely high by the direct lines, while the extra duties charged upon goods arriving indirectly more than counterbalance any savings in transportation charges. The cost of transportation is, therefore, an important factor in the cost of a machine when delivered in France, and the economy realized by paying close attention to the volume of packages may form an appreciable portion of the profits.

The maximum weight of each package must also be carefully considered; freight charges—computed, as has already been shown, according to weight or volume, as may be more profitable to the carriers—are increased very considerably when the weight of individual packages exceeds a certain limit. For instance, the rate for packages exceeding 4½ tons in weight, is double that for packages weighing less than two tons. This increase varies according to the steamship line, but is imposed by all, and must therefore always be taken into account.

In addition to its effect on the actual freight charges, the total weight per package when exceeding a maximum of about two tons, involves extra charges for loading and unloading. These charges vary according to the equipment of the ports of departure and arrival, and are often very considerable—as it may be necessary to move the vessel under a dock crane, when one is available, or to get up steam on a floating crane to handle the heavy weights.

To sum up, it will generally be advantageous to dismount a machine weighing over two tons in order to pack it in several packages, each weighing less than this maximum. Care must be taken, however, that the total tonnage or cubage of the several packages does not exceed that of a single case, and that the difficulties of assembling the machine at destination do not more than counterbalance the economy realized on transportation charges. It is also profitable to dismount a machine weighing either more or less than two tons when this secures a considerable reduction in volume, and when, as is generally the case with machine tools, the cubage exceeds the limit of 40 cubic feet per ton.

Dismounting Fragile Parts.

It is generally necessary to dismount fragile projecting parts, even when this will have no influence on the volume or weight of the packages. While it is true that these parts will be properly protected by the packing case during transportation, still they run the risk of being bent or broken during the operations of unpacking and setting up the machine. It is therefore preferable to remove them, and to pack them in one or more separate boxes secured in the principal case. All delicate or fragile parts which cannot be removed should be carefully protected against rough handling during unpacking. All screw threads should be carefully covered with wood or rags; all tapped holes, oil-holes, and, in general, all openings through which dirt can reach the interior of the machine, should be carefully closed with wooden plugs.

Manufacturers are especially urged to tag all pieces which may have been removed, with labels fully explaining their position on the machine. This precaution may appear exaggerated and useless, if it is considered that the machines will only be assembled by mechanics understanding their construction, but certain American machines are novelties to many factories, and besides, before arriving at the works of the purchaser, the machine has to pass through the Custom House, and sometimes to be exhibited in a sales room. Under these conditions, it is necessary that people, unfamiliar with the type of machine, should know exactly the position and function of each of the detached parts.

Preservation.

When a machine tool has been properly dismounted and divided for packing, the very important operation of protecting the finished parts against rust must be carried out. Lack of care and attention in this operation may have very serious consequences. It is not necessary to point out what serious effects rust may produce on the finished parts of a machine; it should be remembered that after having passed three or four weeks *en route*, often badly protected from the rain, and always subjected to the effects of dampness, a machine may remain during long months in warehouses before being unpacked, and it is easily seen in what condition a machine may be found if the finished surfaces have not been protected against rust by a thoroughly efficient coating.

There are two things to be considered in this question of protection—the nature of the protective coating, and the method of applying it. Without stating what the composition of the coating should be, it is urged that this should be sufficiently fluid at the time of application to permit it to reach all parts of the surfaces to be covered; that it should be entirely free from all trace of acid, in order that it may not attack the metal. It should dry very rapidly, in order that no surface should be exposed accidentally through chafing *en route* or careless handling in the Custom House. It should be readily dissolved with oil, petroleum, or turpentine when the machine is ready to be set up at its final destination.

The coating should, of course, be applied carefully to all polished surfaces which can be reached by the atmosphere, and care should be taken that the coating is intact after the machine has been packed—that is to say, when the packing case has been constructed around the machine. It very often happens that the packers carefully coat all polished parts of a machine, but that more or less of the coating is removed during the handling necessary for placing the machine in its packing case, or by contact with the interior braces. The effects of this negligence are generally very serious, because the parts thus exposed are promptly attacked by rust, and the machine cannot be put in perfect condition, even if this be possible, except by long and costly work. Polished surfaces which are in contact with each other should not be coated; they will be sufficiently protected by the lubricating oil applied for running the machine. Likewise oil holes should be free from the coating composition, as it is most difficult to completely remove it later on.

Finally, it is recommended that this coating be not applied to any finished parts, which, by their position in the machine, are completely protected from all exterior contact, and which are so situated that the removal of the protecting coat would be difficult. For these parts the employment of vaseline or solidified oil is suggested, as this can be readily removed, and, even if not removed, cannot affect the working of the machine. The only precaution to be taken is that the vaseline and oil should be entirely free from acid. As an example, inclosed gearing, such as in the headstock of a lathe, can be protected in this manner against rust. Vaseline or solidified oil may also be employed for protecting such small detached pieces as may be inclosed in a separate box.

Packing Cases.

The packing case must fulfil two requirements; it must effectually protect the machine against all shocks and injury during transportation, and must facilitate the handling of the machine—that is to say, the packing case must be at the same time a covering and a vehicle.

In order to fulfil this double requirement, the case should be specially constructed, and, without fixing general rules, as the details of construction will vary considerably with the forms of different types of machines, the essential requirements will be given for packing cases containing a machine which is of a weight too great for moving by hand.

The bottom is the most important part of the case, considered as a vehicle. If this is well designed, it will not only facilitate handling during transportation from the United States to France, and contribute greatly to removing risk of injury, but it is the only part of the case which can be utilized in France if, after remaining in show rooms, it is to be shipped by rail to its final destination. The bottom should therefore be sufficiently strong to carry the total weight of the machine, without the assistance of any other part of the case, when balanced on a roller. It should be constructed with two longitudinal battens, in order that the case may be moved on rollers when cranes are not available, and these battens should be beveled at the ends to facilitate their employment. Transverse planking, spiked to the battens, forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts, in such manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends, and top of the case, which are designed simply for protecting the machine generally. In constructing the packing case, the remarks already made regarding its volume, must be borne in mind. This volume is computed from the over-all dimensions, and often a bolthead, or a batten, badly placed, will largely increase the cubage.

In designing the packing case, it is very necessary to make provision for the examination of the machine in the Custom House, and even for removing it completely. It is absolutely necessary in all events to arrange an opening in one of the sides or in the cover, through which the nature of the machine may readily be seen. This opening should be large enough to permit the examination of all parts of the interior of the case, and to permit the passage of a lantern, if required. It should be closed by a cover secured with screws. To allow for removing the machine completely from the packing case, in order to determine the net weight of the machine for the Custom House, it should be arranged so that the packing and the unpacking may be readily and rapidly accomplished, without it being necessary to injure the panels. For this it is necessary that the top, and one of the sides, be secured with screws, instead of nails, and that the position of the interior battens and braces be indicated externally, in order that the screws and nails fixing them may be readily found.

It is especially recommended that the interior of packing cases be not lined with paper. Such a lining prevents the circulation of air, and if the machine be packed in a damp atmosphere, the humidity, which under other circumstances would have evaporated, will attack the metallic parts wherever exposed ever so slightly. Special attention is called to this point, as practical experience has demonstrated that effects quite unforeseen by the exporter have resulted from lining cases with paper.

Lists and Drawings.

It is very necessary that the machine should be accompanied by a detailed list of the detached pieces contained in the packing case, which, on unpacking, will show whether any part has been lost during transportation, or during the Custom House examination. It is most indispensable that this list should be accompanied by a drawing or cut showing clearly the machine when assembled and ready for work. This cut should also show all accessories which are indispensable to the machine; for example, countershafts, keys and wrenches, change gears, etc. This cut, in lieu of which a drawing should be supplied, will permit the Custom House inspectors to convince themselves that the detached pieces actually form part of the machine; otherwise, these pieces may have to pay duties at a higher rate than the machine itself. If the machine has been taken apart and made up into several packages, a cut or drawing should be placed in each case, as in general all of the packages are not opened in the Custom Houses. These papers, lists, cuts, and drawings should be carefully enveloped in waterproof paper, and tacked inside the case near the small opening already mentioned, in order that they may be readily accessible. When the dimensions are such that the papers can be attached to the cover of the opening, this should be done.

Exterior Marks.

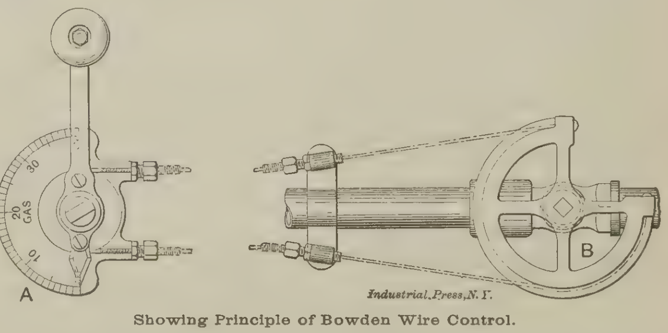
Once the packing is finished, it only remains to properly mark the cases for identification. All manufacturers know that a case should be marked legibly with identifying marks and numbers, the gross and net weight, the volume, and the name of the port of discharge, the latter in legible lettering at least 2 inches in height. It is only necessary to call their attention to the necessity of marking the absolutely exact net weight, as even a very small difference between the weight stated and the true weight may cause difficulties in the custom house; and, perhaps, the imposition of fines. The volume is determined by taking the three dimensions over all. In addition to these marks, indispensable for the transportation of the package, and which should, when possible, be placed on the sides of the case, it is recommended that on each end of the package, a short designation of the contents be added. These last-named inscriptions are absolutely necessary when the package is to be stored in a warehouse, as they permit of the immediate identification of a case containing a given machine. These inscriptions should not only indicate the type of machine, but should also give its size or number.

Finally, exporters are urged to paint a black circle around the heads of all nails and screws which should be removed in order to unpack the machine with the least work, and without injuring the panels and bracings. If the bottom of the case has been given the special form indicated above, there is little chance that it will be placed otherwise than upright; it is, however, better to add usual indications "top," "bottom," etc.

* * *

THE BOWDEN WIRE CONTROL.

The Bowden wire control system has been quite extensively used in Great Britain, it appears, in the construction of bicycles and motor cars, and is applicable to a large range of uses where it is necessary to mechanically operate any device from a distance. It consists essentially of a stranded wire of great flexibility working within an armor of spirally wound wire of much thicker gage. The spiral wire covering, of course, is stationary, while the flexible wire works within it and is connected to the controlling and operated devices. In general two wires are required as indicated in the accompanying cut, which shows the controlling handle at *A* and the stem of a valve in a steam or gas pipe at *B*. The distance separating the two may be considerable and it is not necessary that the connections be made in straight lines. It is being applied for working the inlet and exhaust valves of internal combustion motors and for other novel purposes.



Showing Principle of Bowden Wire Control.

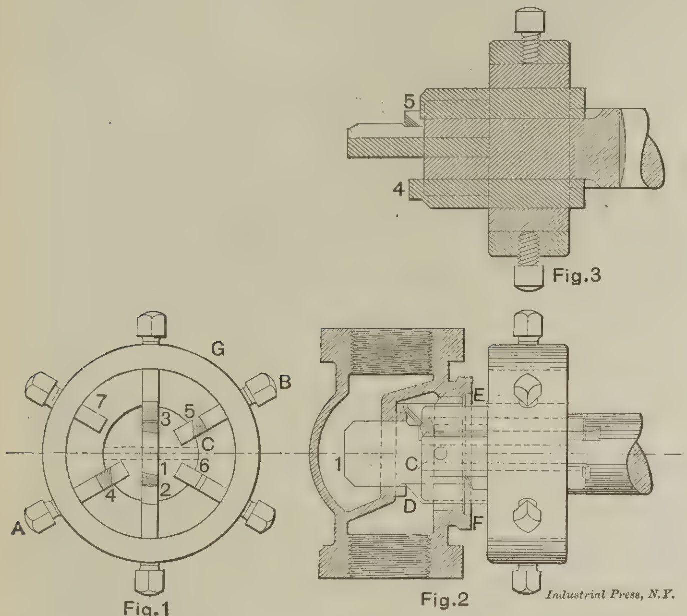
* * *

It is asserted that, under present conditions, the average wear of locomotive tires is 1-16 inch per 9,000 miles. This is a reduction of 2,000 miles within the past few years, and is due to heavier locomotives having greatly increased tractive power. It will be interesting to note what effect the advent of nickel steel tires will have upon average tire wear.

SOME TOOLS USED IN THE MANUFACTURE OF GLOBE VALVES.

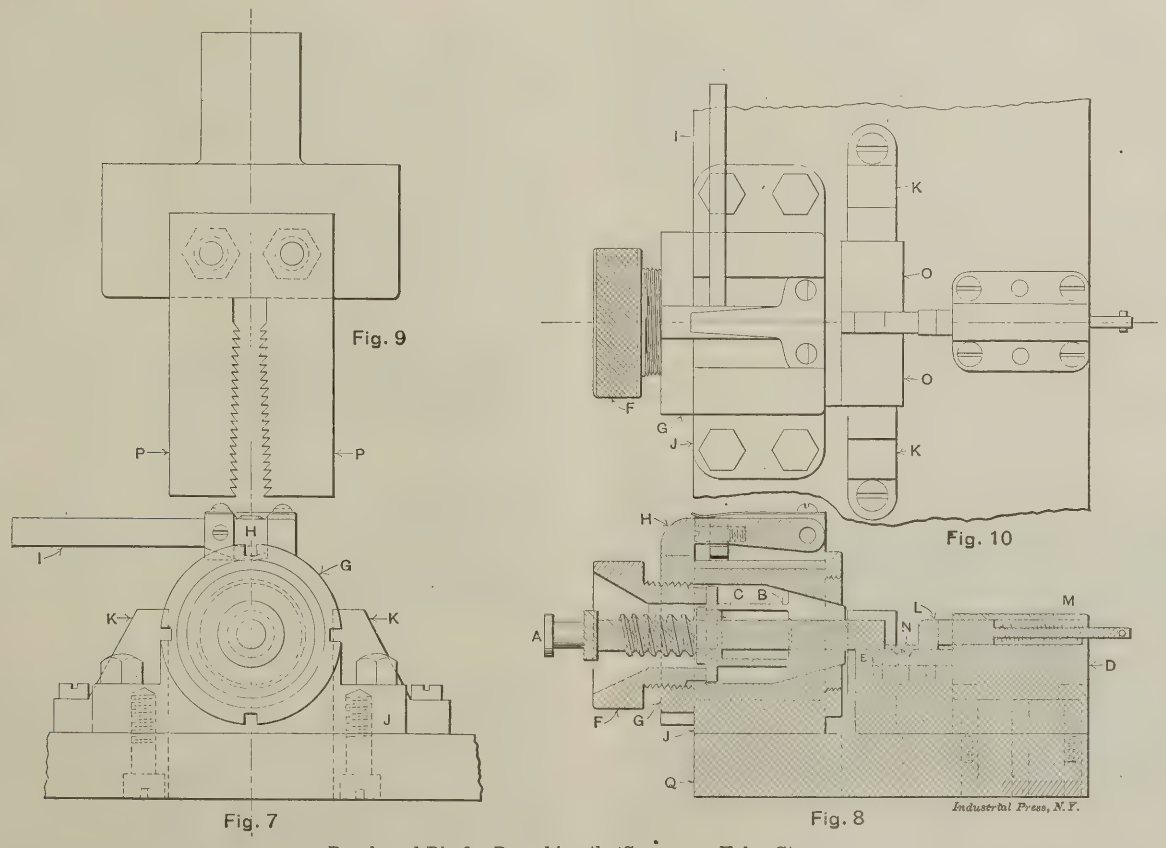
J. R. GORDON.

There is probably no part of the manufacturing field that has had closer pruning in cutting out superfluous operations and expenses than that of the manufacture of steam valves. The labor cost to manufacture globe valves in large quantities is surprisingly low to the casual observer, and to better figures already established would seem to be a difficult undertaking. It was in the hope of so doing, however, that the tools described below were designed. Aided by the modern design of turret lathes and special valve machinery and some of the many labor-saving devices that are on the market, and using high-speed steel wherever practical for the cutting tools, it is believed the object desired has been attained. At the time this is written the tools have been under trial long enough to demonstrate their value. A few slight improvements suggested by usage are embodied in the drawings; otherwise they are practically the same as the original tools. It is not intended in this article to give an extended description of the work of valve manufacture, but I have singled out a few tools that are somewhat special in their design and that may be readily adapted to numerous lines of work.



Industrial Press, N.Y.

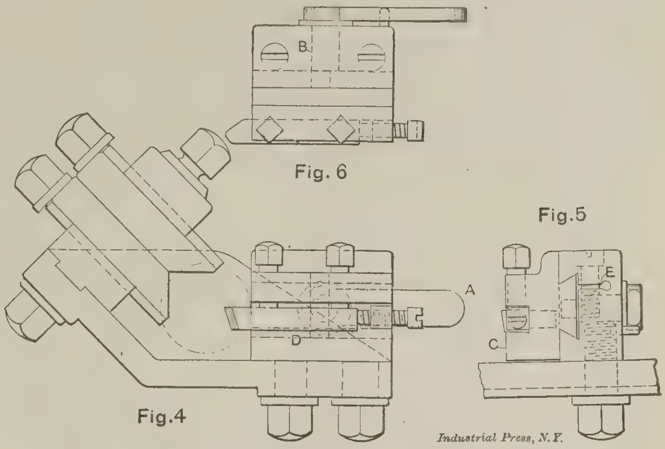
Tool for Boring and Facing the Body of Valve for Bonnet Seat.



Industrial Press, N.Y.

Punch and Die for Broaching the Square on Valve Stems.

Figs. 1, 2 and 3 represent a tool which bores and faces the body part of the valve for the bonnet seat. Fig. 1 is the end view, Fig. 2 the side elevation, and Fig. 3 a cross section on the line *A B*, Fig. 1. The tool consists of a holder with a shank turned to fit the hole in the turret and with slots milled in to suitable depths to receive the cutting blades.



Industrial Press, N.Y.

Box Tool for Finishing Valve Stems.

Over the largest part of the body of the holder a ring, *G*, Fig. 1, is driven on. In this ring and opposite the slots are setscrews that press against shoes which hold the blades in place. The blades are made to take out easily, but are supported against side thrust by the body of the holder.

The blades perform the operations thus: Blade 1 bores out the cored hole in the body, a cross section of which is seen with the tool entered in Fig. 2. This blade is held in the slot milled in the holder by the pin *C*. Blades 2 and 3 chamfer the disk seat inside and outside respectively. Blades 4 and 5, Figs. 1 and 3, bore out the body to receive the tap for the bonnet. Two blades are made, one to balance the thrust of the other; in addition to this work, blade 4 is lengthened to face off the disk seat *D*, Fig. 2. Blade 6 bores the recess *E* for the bonnet seat, and blade 7 faces the bonnet seat at *F*.

Thus the whole seat is finished with one tool. The advantages of this style of tool are that once made it is cheaply maintained, and when any of the blades are dull they may be quickly removed, by loosening the screws that hold them, and sharpened without losing the setting of the machine. The life of the tool is great, since all the grinding can be done on the end of the blades.

Fig. 4 represents the front view of a box tool as constructed by a Cleveland firm, showing also the front view of a sliding tool holder. Fig. 5 shows the side view and Fig. 6 the top view of the holder. With the ordinary box tool, in order to leave a finished surface after the cut is taken it is necessary to back the tool off as slowly as it was driven forward; but this tool obviates this disadvantage. The valve stem which is seen at *A*, Fig. 8, is first chucked by the disk end and the casting finished on the shank part and sized for the thread at the same time, using two tools in the box tool. After the cut is made the lever *A*, Fig. 4, is thrown to an upright position, which, acting on the cam *B*, causes the tool slide *C*, Fig. 5, to move back about 1-16 inch. The cam *B* engages in a slot *D*, Fig. 4, milled across the dovetail in *C*. The bottom of *C* is relieved slightly to permit free movement over the base. Adjustment for wear and freedom of movement is made by slotting the body of the holder *E*, Fig. 5, and taking up the spring with screws. A glance at the drawing will show the method of holding and adjusting the cutting tool in the holder.

Figs. 7, 8, 9 and 10 are drawings showing the construction of a punch and die for broaching the square on the end of the stem to receive the wheel or handle. *A*, Fig. 8, shows the stem in position to be operated upon. It is held in position by the spring chuck *B*, and its position is further determined by the stop bushing *C*. This bushing also serves to center the stem. The stem is supported against the thrust of the cut by the raising block *D*. To prevent wear, a hardened steel piece is fastened to *D*. The spring chuck is forced to its work by the knurled screw *F*, which screws into the spindle *G*. *G* is locked against movement until otherwise desired by the catch *H*, which is in turn opened by the lever *I*. The catch *H* engages in the four slots milled in the flange of the spindle, as shown in Fig. 7. The spindle catch, lever, etc., are housed in the bracket *J*. *K K* are guides to support the cutting blades of the punch against opening thrust while the cuts are being made.

The act of putting the stem in position forces the plunger *L* back, the spring *M* in the housing being light enough to offer but slight resistance. After the first cut is made the spindle is unlocked and a quarter turn is made which brings the stem in position for the next cut. As soon as the stem is revolved into place the shoe *N* on the plunger *L* springs under it, where the cut is made, and supports it for the second cut. The shoe is made slightly tapering to permit a certain entrance under the stem. *O O*, Fig. 10, are openings in the bed to permit the passage of the punches *P P*.

The parts described are mounted on a machine steel plate *Q* which is placed directly upon the bed of the press. The die took up so much room that this was necessary. The stroke of the press is 3 inches and the length of the cutting part of the blades in the punch is 2½ inches, with 21 teeth cut in each. The amount of metal to be removed on each side of the stem is about 1-16 inch. The first tooth on each blade removes about 1-100 inch, and this leaves about .0025 for each of the remaining teeth to remove.

This tool performs its work very rapidly and efficiently.

* * *

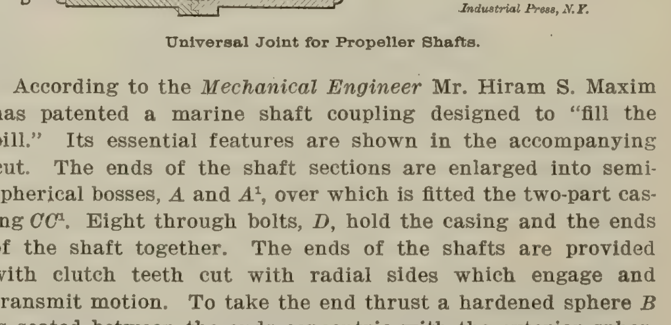
PERMANENTLY EXPANDING CAST IRON.

Most practical men, familiar with steam boiler operation, are, no doubt, also quite familiar with the swelling, warping and permanent enlargement of furnace grate-bars when the fireman neglects to keep them free from clinker or allows the ash-pit to fill up occasionally and choke the draft. Under such conditions the bars are alternately hot and cold, and the result is that they soon become permanently distorted. The remedy, of course, is to keep the grates clean and the ash-pit clear, but, strangely enough, the subject of the permanent expansion of cast iron seems never to have been seriously investigated until comparatively recently. It is referred to at length in an interesting paper read by Mr. A. E. Outerbridge before the Franklin Institute, January 7, 1904. He showed, among other samples, two test bars each of which were originally 14 13-16 inches long and 1 inch square section. One of the bars had been caused to *grow* to a length of 16½ inches and 1⅛ inch section! This means an increase of bulk of over 40 per cent. and a corresponding decrease in the specific gravity, the expanded cast iron weighing at the rate of 375½ pounds per cubic foot, while originally it weighed about 444¾ pounds per cubic foot. The bars treated were heated in a case-hardening furnace (provided with a pyrometer) while inclosed in pieces of pipe sealed with clay to prevent oxidation. When the temperature was limited to 1,200 degrees F., nearly one hundred heatings and coolings were necessary to cause a permanent expansion of 1 inch per foot. But when the temperature was increased to 1,450 degrees F. each heating and cooling caused an increase of 1-16 inch in length. Mr. Outerbridge then showed useful samples of work that had been expanded. The plunger of a small pump had worn until it was 0.006 inch under size; in five heatings and coolings it was expanded 0.045 inch in size or 0.039 inch more than required, thus giving ample material for grinding to size. Another sample was a "pin cam lever" made for a new machine. Some expensive tool-work had been put upon it, as well as upon a duplicate, the pattern having been made in two parts. When this "split pattern" was nearly finished it was found that an error had been made, and both halves were ¼ inch too short and 3-32 inch too narrow. The operator of the case-hardening furnace skilfully expanded both castings, without serious warping, to the required dimensions. A cast iron pulley originally 14¾ inches diameter was permanently expanded 3-16 inch diameter in four heatings; a blank gear 9 3-16 inches diameter was expanded 1-16 inch in five heatings; a bushing 3 9-16 inches diameter was expanded 3-32 inch diameter in fifteen heatings, etc.

* * *

UNIVERSAL JOINT FOR PROPELLER SHAFTS.

The failure of many marine propeller shafts has been traced to defective alignment and flexure of the vessel when in a seaway. The usual form of shaft coupling is perfectly rigid, the ends being flanged and bolted together. If, instead, a coupling could be employed that would combine great torsional strength with a certain degree of flexibility and at the same time stand up well under a heavy end thrust, the effect undoubtedly would be a considerable reduction in the number of propeller shaft failures.



Industrial Press, N.Y.

Universal Joint for Propeller Shafts.

According to the *Mechanical Engineer* Mr. Hiram S. Maxim has patented a marine shaft coupling designed to "fill the bill." Its essential features are shown in the accompanying cut. The ends of the shaft sections are enlarged into semi-spherical bosses, *A* and A^1, over which is fitted the two-part casing CC^1. Eight through bolts, *D*, hold the casing and the ends of the shaft together. The ends of the shafts are provided with clutch teeth cut with radial sides which engage and transmit motion. To take the end thrust a hardened sphere *B* is seated between the ends concentric with the exterior spherical surfaces. The coupling is very strong for its diameter, is symmetrical in form and possesses great torsional strength together with the desirable feature of limited flexibility.

LETTERS UPON PRACTICAL SUBJECTS.

ALLOYS OF HIGH TENSILE STRENGTH.

Editor MACHINERY:

I noted the article on Alloys of High Tensile Strength, by Mr. Herbert E. Field, in the February number of MACHINERY, and regarding this subject I will say that the foundry at the shops of the Rock Island Arsenal make a bronze that must test 60,000 pounds per square inch and they have had it run as high as 80,000 pounds per square inch. This is the bronze used on the 3-inch gun carriage, model 1902, that is built at this arsenal.

The treatment of this bronze as to purity, temperature of heating, method of mixing is as Mr. Field states it in his article. The composition differs though, from Mr. Field's; it is simply 66 2-3 per cent. copper, 33 1-3 per cent. zinc, and a touch of aluminum. No tin and positively no scrap for this bronze, which they call their No. 1. The elongation of this metal is 20 per cent.

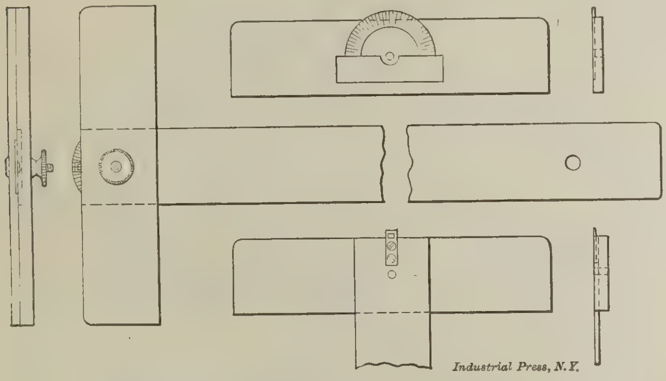
A. D. K.

Moline, Ill.

ADJUSTABLE T-SQUARE WITH PROTRACTOR

Editor MACHINERY:

I have found the T-square illustrated to be very handy when laying out angular work such as is found in jigs and fixtures. It is not shown as anything new, for it is simply an adjustable square, but my object in sending same is to show the addition of a protractor which makes it much handier than most squares.


Industrial Press, N.Y.

Adjustable T-square with Home-made Protractor Attachment.

It will be seen that the protractor is inserted in the swivel portion of the head, the center portion of which was filed away, so that when it was sunk into the wood, there would be stock left around the bolt. The pointer was placed into the fixed head, but the index line was not scribed in position until after assembling, when true position could be found.

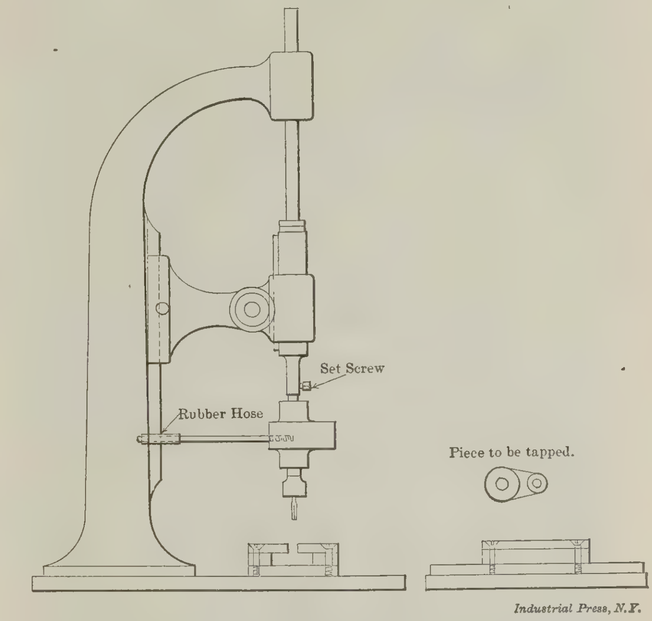
C. E. J.

THE DANGEROUS SETSCREW—A TAPPING RIG.

Editor MACHINERY:

The practice which I have noticed in many shops of putting a setscrew on the drill press spindle cannot be too strongly condemned. Besides being unsightly and a source of frequent accidents the screw will soon strip the thread in the spindle, necessitating the use of a larger screw. The object sought for in most cases is to prevent tapping attachment from dropping out. Besides being a bit heavier than an ordinary drill chuck it must also stand the shock of the reversing clutch, all of which has a tendency to pull out the taper shank. To hold it firmly it is only necessary to seat the taper firmly in its socket, which may be readily accomplished by simply holding a piece of babbitt under the chuck and tapping the other end of the drill spindle with a heavy, soft hammer. This is invariably effective in small, sensitive drill presses, and no further trouble in this direction will be experienced.

I recall an instance where the tapping attachment itself was pronounced "N. G." because of this very trouble. There were a lot of small cast iron links to be tapped, two holes in each, at the rate of about 2,000 a day. After discarding the setscrew and driving the shank into the drill spindle, as suggested, a slide was made consisting simply of three thicknesses of sheet iron screwed together, as shown in the sketch, so as to allow the free passage of the piece to be tapped. By clamping this slide to the drill-press table the necessity of locating the hole to be tapped and of preventing the piece from turning while being tapped, was entirely obviated. The same device was later used in connection with a friction chuck for tapping the same holes in steel, it having been found desirable to increase the strength of the links without increasing their size.



Industrial Press, N.Y.

Tapping Rig.

I have always found that tapping by this method has the same advantage over horizontal tapping, as a vertical milling-machine has over a horizontal spindle milling machine, namely, the operator is better able to follow the work in his natural position than when he is bending over it.

New York. H. J. BACHMANN.

EXPLOSION OF WATER FRONT.

Editor MACHINERY:

It would be hard to find a more inoffensive and innocent-looking machine than the ordinary kitchen range—but that it can have wild moments at times the photographs enclosed will show. They also will show that cast iron under steam pressure is apt to be dangerous.

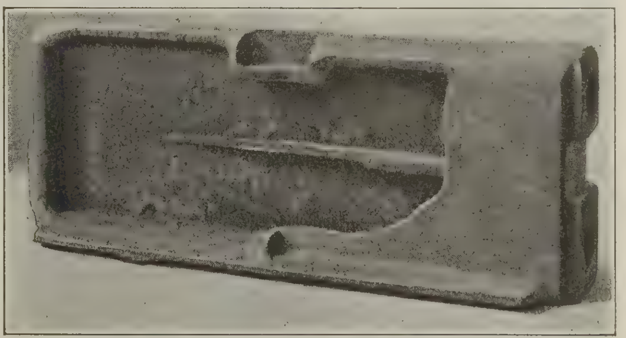


Fig. 1. Water-front of Kitchen Range after Explosion.

The explosion of the water front shown in Fig. 1 took place at Worcester, Mass., on the morning of February 4 and caused damages to the extent of about $125. The hot water tank connected to the water front was located in a closet in a room adjoining the kitchen, the connecting pipes passing through two walls about one foot apart. A fire left in the range over night became so low that a fresh one was started in the morning, but the water in the tank was warm enough for bathing purposes and was used for such up to the time of the explosion. The explosion was terrific and not only wrecked the range but hurled the fragments against the walls sufficiently hard to split and crush the wood-work. The room was set on fire which, however, was easily extinguished as the floors were of hardwood. Two people were in the kitchen at the time of the explosion, but were not hit by the pieces.

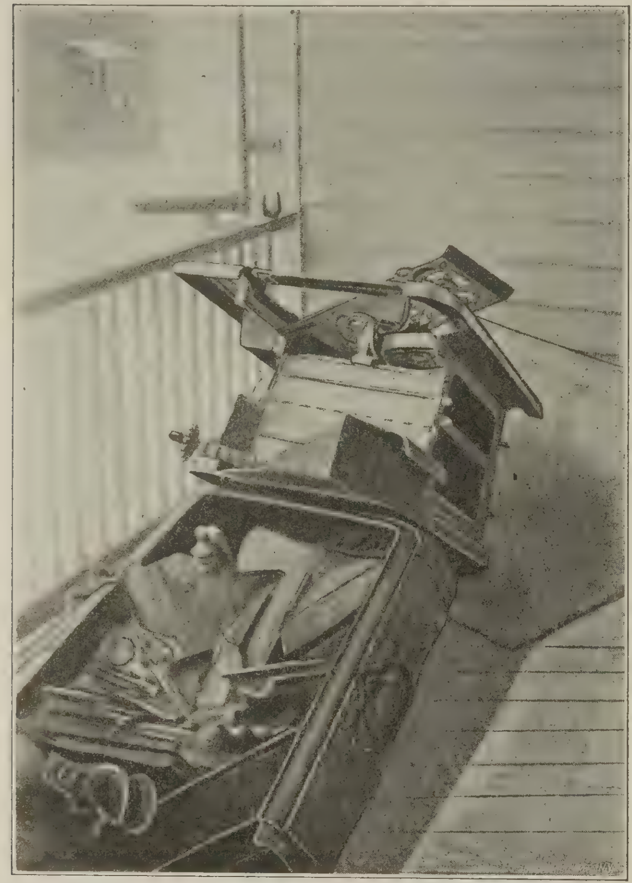


Fig. 2. Ruin of the Range.

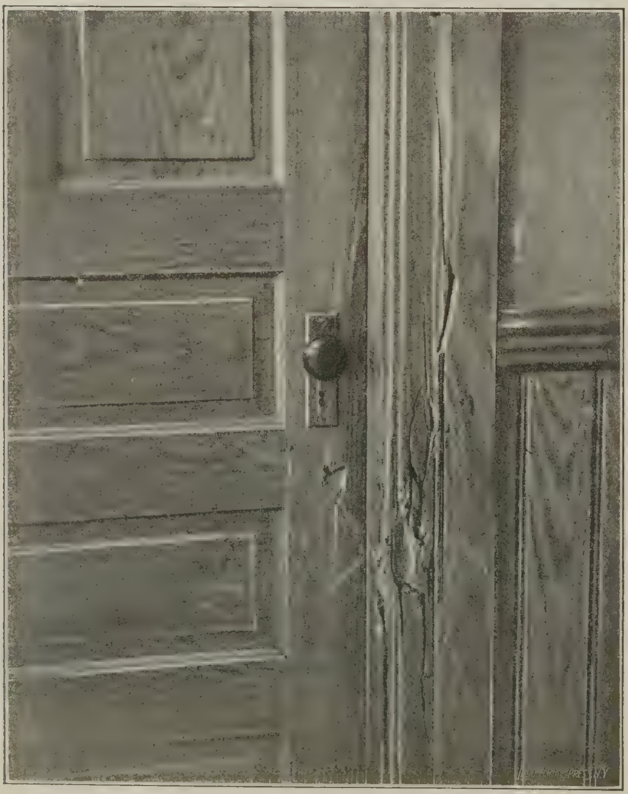


Fig. 3. Where one of the Fragments Struck.

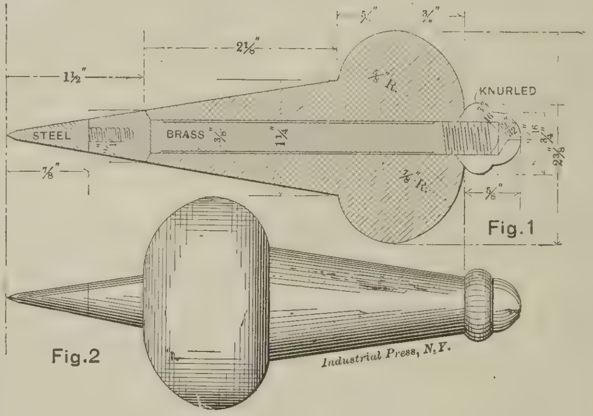
Fig. 1 shows the cast iron water front as it looked after the affair. Fig. 2 gives an idea of the wrecked range; those parts of the range not actually forced apart were cracked and broken beyond repair. Fig. 3 is where one of the flying pieces struck, and gives an idea of the force of explosion. It is supposed that either the pipes were frosted where they passed between the walls or that sediment collected at their juncture with the water front itself. A coil of pipe instead of the cast iron front would undoubtedly have prevented so serious a result, as it would simply have split, relieving the pressure without explosion. H. P. Fairfield.

[In a later letter Mr. Fairfield says that since hot water could be and was used throughout the morning, no suspicion, naturally, was felt that all was not well with the pipes. The trouble, of course, lay between the range and the boiler. A number of similar explosions occurred during the past winter, which indicate that the water front kitchen range will bear close watching, especially in severely cold weather.—Editor.]

ANOTHER PLUMB BOB FOR SHOP USE.

Editor Machinery:

I noted with interest the drawings and description of plumb bobs in the January number of Machinery, but find that the one shown in the sketch herewith has several advantages for shop use. If made of brass to the dimensions given, the bob will weigh about 1⅞ pounds, but it may, of course, be made any size to suit the user's taste. The body, cap and center pin are of brass with a small steel point screwed in, as shown in the details. The cap is knurled on the edge and has a small hole drilled for the line.



Plumb Bob for Shop Use.

The taper shoulder on the pin and cap causes the pin to center accurately, whether it is a perfect fit in the body or not. This arrangement permits of the body being reversed, when desired, as shown in Fig. 2, in which case it will come to rest more quickly than when used in the regular manner. When a light plumb bob is desired for working near a wall or in a small hole, the body may be removed entirely and the pin and cap alone used. S. M. Preston.

Ouray, Colo.

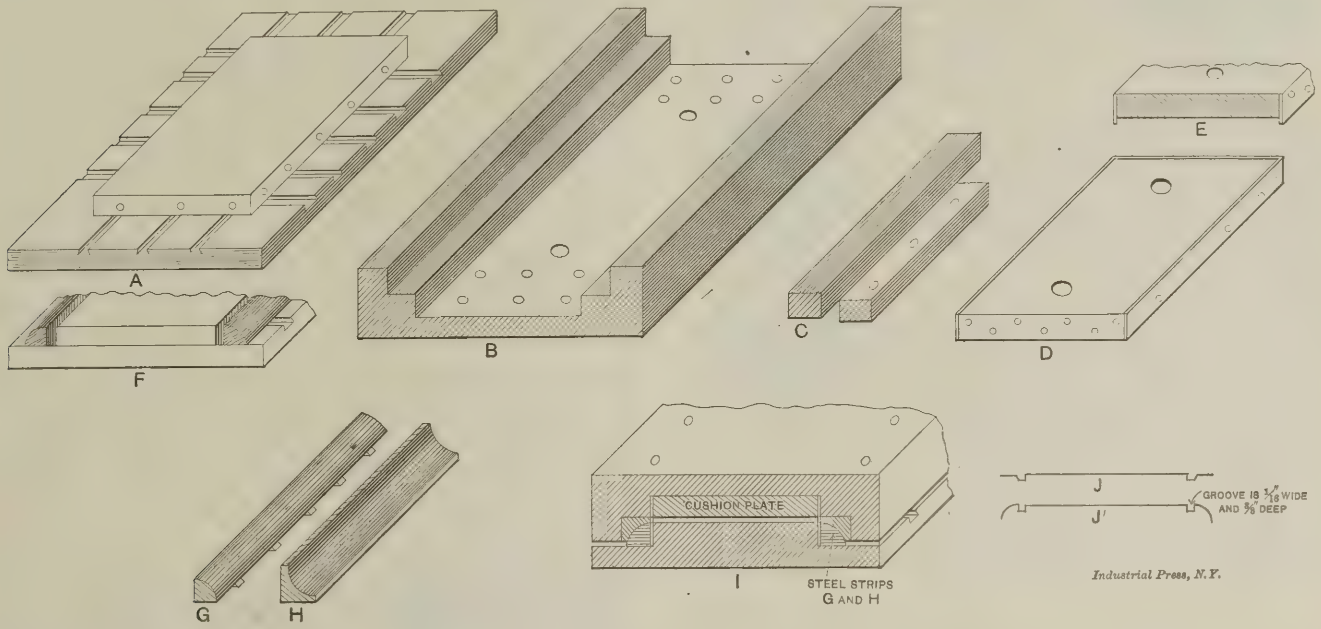
DECIMAL THREADS.

Editor Machinery:

Since the publication of the article on cutting fractional screw threads in the November, 1903, issue, I have had a number of inquiries in regard to "decimal threads," meaning that the pitch is expressed in decimals of an inch. This means that a thread 4 to the inch or ¼-inch pitch would be expressed as .25 or 25-100 pitch. From the source of these inquiries I feel they come from government shops and that this method of designating is not common or likely to become so. Still, as it will not require much space to make it clear, I shall ask the editor for his further indulgence.

As in the case of the fractional threads it is only necessary to consider both the lead screw and the screw to be cut in the same terms, remembering that it is the "equivalent" lead of the lead screw that must be taken. This was carefully explained before and need not be repeated. It is an awkward way to designate a lead, but you can master it just the same. Suppose your equivalent lead screw is 5 to the inch. This expressed decimally would be .20 inch. Now if the screw to be cut has a lead of .40 inch it is evident that it is twice as fast as the lead screw, and that the lead screw must turn twice as fast as the spindle. The ratio is 2 to 1 and a 48 on the stud and a 24 on the lead screw will do the work.

It is where the lead of the work and the lead screw cannot be expressed in a simple ratio that the trouble comes in figuring it out. Suppose the drawing calls for a thread .15 lead and you have the same lead screw as before. Then it is a case of 15 to 20, or dividing each by 5, is 3 to 4. Any gears bearing this ratio such as 24 and 32, or 30 and 40, will cut the thread. It often happens, however, that the lathe builders make lead screws that do not divide up in even decimals as the one taken. They are quite frequently made 6 to the inch, which gives a lead of .166666, etc. (as long as the sixes hold out). This is what raises a fog when we come to try and cut that .15 lead thread. The ratio is .15 to .166 (if we decide to only use three decimal places), which can also be called 150 to 166, as we must keep the same number of decimals. The ratio is a little over 1.1 to 1, and it is often easy to find gears for this ratio in an ordinary lathe equipment. Trying 40 and multiplying it by 1.1 we get 44, which we can probably find, but could not do it with any others in the train unless there happened to be 60 and 66 or 80 and 88. As the thread to be cut is a little faster than the lead screw, the large gear must go on the stud. But the thread will not be exactly the lead, as we dropped some of the decimals. Still it is the best we can do on an ordinary lathe.



Industrial Press, N.Y.

Fig. 1. Punch and Die for Forming Base of Steel Range.

One more example and I am through. Lead screw 6 to inch or .166 lead, and screw to be cut ⅜ or .375 inch lead. Dividing .375 by .166 we get 2.23 as the ratio. We will have to call this 2.25 or 2¼, even if it is not exact. Then trying a 24 as the smallest and multiplying it by 2¼ we have 54 as the gear for the stud. This is a case where common fractions are easier and more exact, as they come out even. Calling the lead screw 1-6 and the pitch of screw to be cut ⅜ we can reduce them both to 24ths and get 4-24 and 9-24. Then the ratio is 2¼ to 1, as we assumed before, after finding that the decimals did not come out right.

Decimals are very useful in many ways, but when it comes to figuring leads of screw threads they are not in it with plain, raw, common fractions.

FRED. H. COLVIN.

PUNCH AND DIE FOR FORMING THE BASE OF A STEEL RANGE.

Editor MACHINERY:

Having seen and read a great deal of late in MACHINERY about punch-and-die work I will describe a die which I designed for forming the base of steel range stoves that are made in our shop.

This die performs the second operation on the base which is already formed to the shape shown in reduced scale at *J*. *A* is the die-block upon which the steel sheet *J* rests during the operation. It is of composite structure, the four pieces, *G*, being placed at the sides and ends as indicated at *F*, which is a sectional view of the bottom die with the side pieces *G* in position. The top part or punch is shown at *B*. It is inlaid with steel strips of the shape shown at *H*, which form end and side pieces to match the pieces *G* in the bottom die. The pieces *C* are fitted across the channels in *B* to hold the steel end pieces and to complete the shape of the punch. The cushion plate *D* is fitted with side strips which project about ¼ inch below its base. This is indicated in the cross section of the cushion plate at *E*. The reason for having these strips on the cushion plate is that they drop into the previously formed groove in the sheet and over the edges of the die-block and hold the piece from jumping up when the side forming pieces move inward.

The lower die plate *A* has dovetailed grooves planed at right angles for the reception of the similar shaped projections on the bottoms of the steel strips *G*. The holes shown in the elevated portion of *A* are for springs which shove the side pieces back when the punch ascends after the forming operation is completed. A section of a completed base is indicated in reduced scale at *J′* and a complete base is shown in the half-tone, Fig. 2. At *I*, Fig. 1, is shown a sectional view of the punch and die when closed.

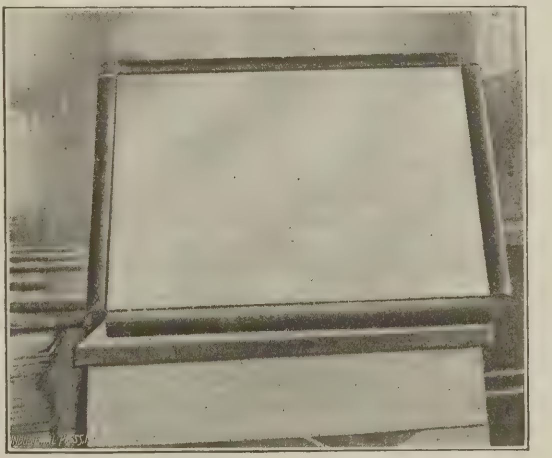


Fig. 2. The Base, after Forming.

This die is made for three sizes of stoves, the bases of which measure 29 x 20 inches, 31 x 20 inches, and 33 x 20 inches.

Lorain, Ohio. W. VAN ORMAN.

TO CALCULATE THE SETTING OF THE DIVIDING HEAD WHEN CUTTING THE TEETH OF END MILLS.*

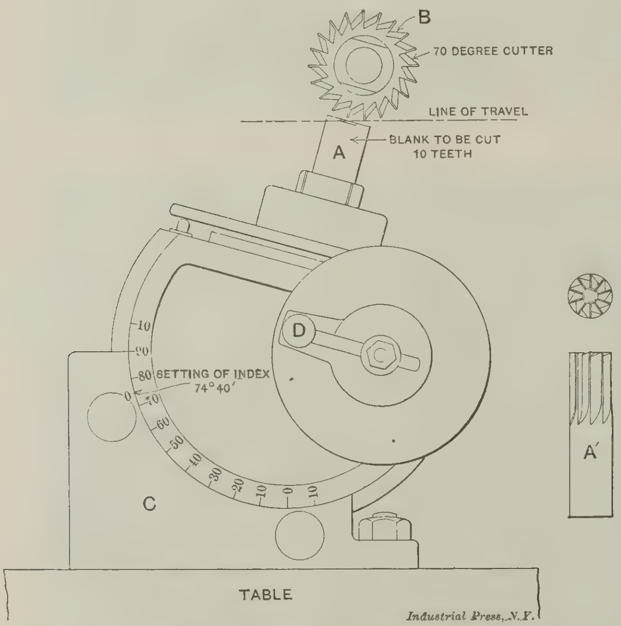
George G Porter.

Editor MACHINERY:

In cutting the teeth on face and end mills the cut-and-try method is nearly always used in getting the index head set at the proper angle, and, indeed, most of the toolmakers and machinists know of no other way of doing it, but I have devised a very simple rule, and thinking perhaps the readers of MACHINERY would appreciate it, have arranged the following tables so that anyone who knows how to multiply can calculate the angle at which to set the head much quicker than by cutting and trying. And then, too, there is a certain satisfaction in being able to figure out a thing of this kind. The rule is:

Multiply the tangent of the tooth angle by the contangent of the cutter angle, and the result is the cosine of the angle at which to set the head.

The rule and use of the tables is best explained by an example. Suppose it is desired to cut a face mill with 29 teeth and we are to use a 70-degree cutter. Then looking in Table I. we find the tangent of the tooth angle to be .22012, and looking in Table II. we find the cotangent of the cutter angle (70 degrees) to be .36397; multiplying these two numbers together we get .08012, which is the cosine of the angle at which to set the head. Looking in Table III. for this number or the number nearest to it, we find it to be .08136, and the corresponding angle to be 85 degrees 20 minutes or 85 1-3 degrees. A sufficiently close result is obtained if we use the first three figures of the tangent and cotangent in Tables I. and II. respectively (of course increasing the third figure by one, if the fourth figure is five or more).



Industrial Press, N.Y.

Dividing Head set for Cutting End Mill having ten Teeth.

Perhaps for the benefit of the younger readers it will be well to work out one more example and from the data make a sketch showing the index head *C* in position on the table of the machine, and the cutter *B* on the arbor ready to take the first cut through the blank *A*.

Suppose we are to make an end mill with ten teeth and are to use a 70-degree cutter. Looking in Table I. we find the tangent of the tooth angle to be .727 (using first three figures), and from Table II. we find the cotangent of the cutter angle to be .364; multiplying these two numbers together we get .26354. In Table III. we find the number nearest to it to be .26443, and as this number (.26443) is opposite 74 degrees and in the column headed 40 minutes, 74 degrees 40 minutes is the angle at which to set the head. This angle is just a little less than 75 degrees, as will be seen by referring to the sketch.

In the sketch an end mill blank is shown as being held in a split collet, which is used to hold such mills when they are used in the spindle of the milling machine. At *A′* is shown the end mill as it is to look when finished.

TABLE I. TOOTH ANGLES AND THEIR TANGENTS *

Number of Teeth.	Angle.			Tangent.	Number of Teeth.	Angle.			Tangent.
	Deg.	Min.	Sec.			Deg.	Min.	Sec.	
5	72	....	......	3.07768	31	11	36	$46\frac{14}{31}$	.20550
6	60	....	......	1.73205	32	11	15	......	.19891
7	51	25	$42\frac{6}{7}$	1.25396	33	10	54	$32\frac{8}{11}$	.19273
8	45	....	......	1.00000	34	10	35	$17\frac{1}{17}$	.18693
9	40	....	......	.83910	35	10	17	$8\frac{4}{7}$	.18147
10	36	....	......	.72654	36	10	....	......	.17633
11	32	43	$38\frac{2}{11}$	.64266	37	9	43	$47\frac{1}{37}$	.17147
12	30	....	......	.57735	38	9	28	$25\frac{5}{19}$	.16687
13	27	41	$32\frac{4}{13}$	.52484	39	9	13	$50\frac{10}{18}$	.16251
14	25	42	$51\frac{3}{7}$	.48158	40	9	....	......	.15838
15	24	....	......	.44523	41	8	46	$49\frac{31}{41}$	.15446
16	22	30	......	.41421	42	8	34	$17\frac{1}{7}$	.15073
17	21	10	$35\frac{5}{17}$	.38740	43	8	22	$19\frac{23}{43}$	.14717
18	20	....	......	.36397	44	8	10	$54\frac{6}{11}$	.14378
19	18	56	$50\frac{10}{19}$	.34330	45	8	....	......	.14054
20	18	....	......	.32492	46	7	49	$33\frac{21}{23}$	.13745
21	17	8	$34\frac{2}{7}$	.30846	47	7	39	$34\frac{22}{47}$	.13449
22	16	21	$49\frac{1}{11}$	.29362	48	7	30		.13165
23	15	39	$7\frac{19}{23}$	.28019	49	7	20	$48\frac{48}{49}$	.12893
24	15	....	......	.26795	50	7	12	......	.12633
25	14	24	......	.25676	52	6	55	$23\frac{1}{13}$	.12141
26	13	50	$46\frac{2}{13}$	.24648	54	6	40	......	.11688
27	13	20	......	.23700	56	6	25	$42\frac{6}{7}$	.11267
28	12	51	$25\frac{5}{7}$	.22824	58	6	12	$24\frac{24}{29}$	.10875
29	12	24	$49\frac{19}{29}$	.22012	60	6	....	......	.10510
30	12	....	....	.21256	.....	....	.....	.....	....

TABLE II. CUTTER ANGLES AND THEIR COTANGENTS.*

	50°	55°	60°	65°	70°	75°	80°	85°
Cotangent.	.83910	.70021	.57735	.46631	.36397	.26795	.17633	.08749

TABLE III. COSINES.*

Degrees.	Minutes.					
	0	10	20	30	40	50
60	.50000	.49748	.49495	.49242	.48989	.48735
61	.48481	.48226	.47971	.47716	.47460	.47204
62	.46947	.46690	.46433	.46175	.45917	.45658
63	.45399	.45140	.44880	.44620	.44359	.44098
64	.43837	.43575	.43313	.43051	.42788	.42525
65	.42262	.41998	.41734	.41469	.41204	.40939
66	.40674	.40408	.40141	.39875	.39608	.39341
67	.39073	.38805	.38537	.38268	.37999	.37730
68	.37461	.37191	.36921	.36650	.36379	.36108
69	.35837	.35565	.35293	.35021	.34748	.34475
70	.34202	.33929	.33655	.33381	.33106	.32832
71	.32557	.32282	.32006	.31730	.31454	.31178
72	.30902	.30625	.30348	.30071	.29793	.29515
73	.29237	.28959	.28680	.28402	.28123	.27843
74	.27564	.27284	.27004	.26724	.26443	.26163
75	.25882	.25601	.25320	.25038	.24756	.24474
76	.24192	.23910	.23627	.23345	.23062	.22778
77	.22495	.22212	.21928	.21644	.21360	.21076
78	.20791	.20507	.20222	.19937	.19652	.19366
79	.19081	.18795	.18509	.18224	.17937	.17651
80	.17365	.17078	.16792	.16505	.16218	.15931
81	.15643	.15356	.15069	.14781	.14493	.14205
82	.13917	.13629	.13341	.13053	.12764	.12476
83	.12187	.11898	.11609	.11320	.11031	.10742
84	.10453	.10164	.09874	.09585	.09295	.09005
85	.08716	.08426	.08136	.07846	.07556	.07266
86	.06976	.06685	.06395	.06105	.05814	.05524
87	.05234	.04943	.04653	.04362	.04071	.03781
88	.03490	.03199	.02908	.02618	.02327	.02036
89	.01745	.01454	.01164	.00873	.00582	.00291

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* All rights reserved by Geo. G. Porter.

*The tables given above are reproduced for the convenience of those readers who do not possess any one of the many handbooks containing such data. The angles whose tangents, cotangents and cosines are given, cover the range of all ordinary shop practice, but should other angles be wanted they may be found, of course in Haswell's, Kent's, Trautwine's, Suplee's or any other engineers' handbook containing tables of sines, tangents, etc. For use in the tool-room we shall doubtless publish the angular settings for mills of 5 teeth up, in a future data sheet.—EDITOR.

One looking at the sketch might be led to think that the teeth were cut on the end of the blank first, but such is not the usual practice, as it is more convenient to cut the side teeth first. The sketch was drawn this way to avoid confusion.

The line passing through the end mill blank in the sketch shows the line traveled by the points of the teeth of the 70-degree cutter. The line was so drawn to show how the teeth run out at the center of the blank but in actual practice the milling cutter is not set down to this line, as the spaces would be cut too deep, bringing the teeth of the end mill to a sharp edge, whereas they should have a narrow flat place left on top, called the land. GEORGE G. PORTER.

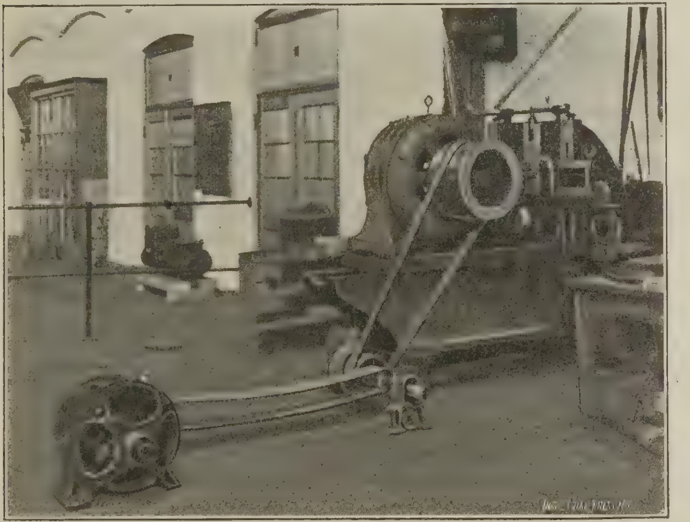
Syracuse, N. Y.

TURNING A PULLEY ON A PLANER.

Editor MACHINERY:

The writer had occasion to true up a brake wheel or drum which was on the shaft of a 25-horsepower induction motor. This drum had to be exactly true, as it was to be used in testing the efficiency of the motor and ascertaining the brake horsepower. Our lathe was too small to swing it and it was impracticable to take out the armature shaft to send away. Accordingly it was "up to the writer" to devise some means for accomplishing the desired result, which was done in the following manner:

We placed the motor in question on the bed of a 24 inch by 24 inch planer, with the pulley face parallel with the cross-rail, clamping the motor to the platen in the usual manner for planing. A heavy tool was clamped in the tool-holder and allowed to extend above the top strap on the clapper tongue. To its side a lathe (turning) tool was clamped rigidly with the strap, before mentioned, as a support. To regulate the depth of cut, the table was advanced by turning the driving pulley on hand. Next a temporary jackshaft was rigged and placed, as shown in half-tone, which received its power from a 5-horsepower shunt-wound motor. It will be noticed that the belt from the driving motor is from a large to a smaller pulley; and also runs the other belt on the second size pulley on the jackshaft to the drum. This is the arrangement I used to file and polish after turning with tool. When the turning was being done I had the following hitch: From the pulley on the small motor (which is 6 x 6 inches) to the large pulley on the jackshaft (which is 12 x 4 inches) by a 4-inch belt, and thence from the smallest pulley on the jackshaft (4 x 4 inches) to the drum (12 x 18 inches) by a 2½-inch belt.



Turning a Pulley on a Planer.

I used this arrangement to allow sufficient speed in the driving motor to gain power to do the work. Or, to put it more plainly, if the speed of the small motor was reduced enough to permit belting directly to the large drum for proper cutting speed—which result would be accomplished by putting a large resistance into the armature circuit—it would be found that the torque of the motor was almost destroyed. Therefore by allowing the motor to run at higher speed it developed greater torque, which was proportionally increased by the jackshaft and pulley arrangement. By actual measurement the field current was 230 volts and the armature current was 38 volts, additional resistance having been put in the armature circuit to reduce the speed.

As the belt was way over to the extreme edge of the drum, I turned it to size as far as possible and then changed the position of the drive by loosening the collar on the jackshaft and sliding it along till the belts would run on the opposite edge of drum. This job was done in an electrical engineering laboratory where every facility was easily obtainable.

Cambridge, Mass. HOWARD M. WEBBER.

A SIMPLE CASE OF COMPOUND INDEXING.

Ralph E. Flanders.

Editor MACHINERY:

In cutting odd gears on a milling machine it is a common and annoying occurrence to find that the number of teeth desired, although not prime, is just beyond the range of the index plate. If the desired number of teeth is an even multiple of an indexing given in the table, say 2 or 3 or 5 times as large, a little knowledge of the principles of compound indexing will help one out of the difficulty. The method given here is simpler than that employed for prime numbers. A close approximation can always be obtained, and usually an exact indexing can be discovered.

Suppose we wish to cut a 96-tooth gear. This division is not given on the table, but we find that we can cut every other tooth by indexing for 48 teeth—15 holes in the 18 circle, as the table gives it. In this manner we cut around every other tooth in the whole circumference. Now the problem is to index the blanks such a distance that the cutter will halve the space between two adjacent cuts and make two perfect teeth. As soon as this is done, we may take 48 more cuts with the original indexing and thus complete the unfinished teeth.

To move the blank 1-48 of a revolution, or a distance of 2 teeth, take 15 holes in the 18 circle, or 15-18 of a turn of the index handle. To halve the tooth we must rotate the handle one-half of this amount, $\frac{1}{2} \times \frac{15}{18} = \frac{5}{12}$ of a revolution. The plate on the head is kept from turning by a pin which enters one of the holes in the outer or 20-hole row. If the plate be moved until the stop-pin enters the next adjacent hole, the worm has turned 1-20 of a revolution, while if we move the index pin 1 hole in its circle, the worm has turned 1-18 turn. The solution of the problem lies in finding a certain number of holes to move the plate past the stop-pin, which, combined with a suitable movement of the index-pin will give the required movement of 5-12 of a revolution to the blank.

A movement of the index-pin one hole gives 1-18 revolution to the worm. If the plate be moved one hole past the stop pin, the worm is moved 1-20 revolution. It is desired to move it 5-12 revolution; reduced to a common denominator these fractions become $\frac{10}{180}$, $\frac{9}{180}$ and $\frac{75}{180}$ respectively. By inspection of the numerators we readily see that:

$$\left(3 \times \frac{10}{180}\right) + \left(5 \times \frac{9}{180}\right) = \frac{75}{180}$$

In other words, a movement of 3 holes ahead of the index-pin in the 18 circle, followed by 5 holes with the stop-pin in the 20 circle, will, when added together, move the blank into position to index around the second time to cut the remaining 48 teeth.

Cases often occur in which it is impossible to get an absolutely accurate indexing by this method. Perhaps the following example will show a good way to obtain a close approximation in cases of this kind, and also make plain the method of allowing for whatever slight error there may be.

Supposing we wish to cut a gear with 63 teeth. On looking at our table we find that the best we can do is to cut 21 teeth, three times around. Start out to find the compound indexing the same as in the previous, remembering that we wish to find 1-3 of the regular indexing instead of ½. The indexing for 21 teeth is 40 holes in the 21 circle. On this plate the stop-pin enters one of the holes in the outer or 33 row. Reckoning as in the previous case, a movement of the index pin one hole will give the worm 1-21 revolution. Moving the plate one hole past the stop-pin will give the worm 1-33 revolution. We desire to give it 1-3 × 40-21 = 40-63 revolution. Reducing 1-21, 1-33 and 40-63 to a common denominator we have 33-693, 21-693 and 440-693 respectively.

We may try, if we wish, to find combinations of the first two fractions which added together will give the last, but a moment's thought will show that it is impossible. The numerators 33 and 21 are both multiples of 3, so all conceivable combinations of these numerators must of necessity be also multiples of 3. Inasmuch as the desired numerator, 440, is not divisible by 3, we must evidently content ourselves with an approximate solution. If we say that 441-673 revolution of the worm is near enough for our purpose, a little figuring will show us that (7 × 33-693) + (10 × 21-693) = 441-693, or in other words, 7 holes ahead with the index pin in the 21 circle, followed by 10 holes ahead of the plate past the stop-pin, will approximately divide our indexing into thirds, and bring our cutter into position to cut another set of 21 teeth around.

It is practicable to make allowance for the error we have introduced into our calculations. The indexing worked out above will revolve the worm 441-693 of a turn. As we found the correct amount to be 440-693, this approximation carries the worm 1-693 of a revolution too far. As the worm moves 40 revolutions to 1 of the wormwheel, the blank has been turned $\frac{1}{693 \times 40} = \frac{1}{27{,}720}$ revolution too far. Suppose we are cutting a 10-pitch gear. Then the pitch diameter for a 63-tooth gear is 6.3 inches, and the pitch circumference is 6.3 × 3.1416 = 19.72 inches, about. The blank was found to be turned $\frac{1}{27{,}720}$ revolution too far; therefore, it has gone on the pitch circle $\frac{19.72}{27{,}720} = .00071$ inch too far. If now the saddle of the milling machine be moved along the knee to bring the blank back past the cutter about .0007 after each compound indexing, we may preserve the proper thickness of tooth all the way around. The cutter had best be re-centered after every two or three gears, as this movement, if made often enough, will finally throw the cutter too far to one side.

In hunting for combinations of compound indexing, and other work of this kind, a person whose mind takes naturally to mathematics will discover rules and ways of working, which will change the search from a blind hunt to a systematic one, thus saving considerable time and worry.

When this method of indexing can be used, the reduction in the number of double indexings, and consequently, in the number of chances for mistakes, gives it an appreciable advantage over the strictly compound method.

Nashua, N. H. R. E. Flanders.

* * *

BORING BAR FOR CHUCK WORK.

Editor Machinery:

The accompanying sketches show a boring bar for boring long holes in pieces chucked in an ordinary hollow spindle lathe. The sizes and length of the bar are governed by the diameter and length of the hole to be bored. One end of the bar is flattened to fit the tool post, and the other is supported by a bushing in the lathe spindle. The flattened end should have its center that was used in turning left in, so that it can be properly lined up when clamped in the tool post by using the tailstock center. It will be observed that the tool cannot be fed into the work by using the cross slide, as this must remain stationary or it will result in a tapered hole.

In boring holes, as shown in Fig. 2, a reamer can be built on the bar just back of the cutter, but must be far enough back to allow the cutter to pass through into the large cored part before the reamer enters. By referring to the sketch it will be seen that there is room between the end of the lathe spindle and the work for the cutting tool while the reamer is reaming back side of hub. C. P. L.

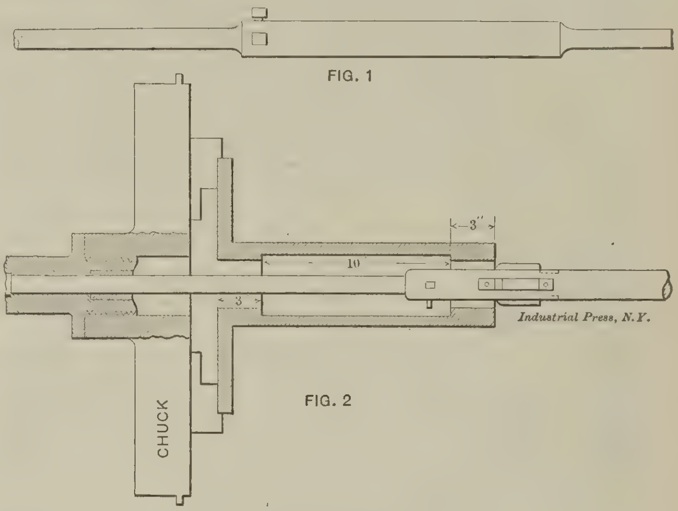


FIG. 1

FIG. 2

Industrial Press, N.Y.

Boring-bar for Chuck Work.

THE ETERNAL QUESTION.

Cornell Ridderhof.

Editor Machinery:

"Frank, how many thirty-seconds are there in an inch?"

Frank took a steel rule and with the aid of his finger-nail succeeded in finding thirty-three!

This young man had "worked at the trade" about eighteen months before he came to us. We had him doing rough lathe work and the like, and on easy work that meant little more than the repetition of a series of movements, he did fairly well, considering—yes, considering that he could not think. Of course Frank was not paid as much as he thought his labor was worth, so felt that he was doing us a favor by working for us, and when one day a job was given him which he considered beneath his dignity to do, he promptly refused and was as promptly dismissed.

More than one young man has come into and left our shop in the same manner. By chance they are brought into a machine shop, as they have been advised to learn a trade and thinking the machinist's trade as good as any, they will just learn that. They learn it like a monkey learns to strike matches—by mere imitation. Now intelligent imitation is a good thing; it is *necessary*. Were it possible to stop it there could be no progress; but the mere mechanical imitation of what we see others do, without knowing, nor caring to know the why and wherefore, renders a human being a mere automaton—a piece of machinery.

I hear some one remark: "That boy might have done real well at some other trade," with which I do not agree. I do not happen to be sufficient of a jack-of-all-trades to be acquainted with many but I have yet to hear of a trade in which a man who cannot think can be successful. As in machinist's work, there are some operations in other trades he might learn to do, as before stated, like an automaton, but he no more will know that trade than a phonograph with a French record on it knows French.

It must be true that many men are "cut out" for certain work and yet there is a whole lot of truth in it that a man who is successful in one line of work, should he give all his energy to it, would be successful in another. Only it means good hard work in the right direction and right where one is.

Not what "we would do if we only were in such or such a place," but as Bob Fitzsimmons said, "hit from where your hand is." Failing to appreciate the value of doing the best they can *anywhere* is a fault common to the boys. They can't sweep the floor well before they want to get on a machine; before they can drill a hole where it is wanted they "want to get on a lathe," and so on. And then, on any machine, they want to pick out their own jobs (a "snap" usually) and vise work is despised as if it were degrading.

Perhaps the reader expects me to suggest a remedy. Most of us are ready with advice, but it is too often of the kind that was given the driver of a balky horse: "Just get 'er started and she'll go." But they don't tell how to "get 'er started." So with the boys. Get them to see that they cannot float upstream, nor slide down to the top of the ladder; that they must work, not only with their hands but as well with the small part of their brain that is awake, and once this is started the rest of the gray matter will be aroused and it will surprise all to see what they are capable of doing when aroused out of their lethargy. It is easy to give advice like this, but not so easy to follow it. I have tried it and sometimes with a degree of success, but the thought that only the more willing, energetic ones responded robbed me of all self-conceit. CORNEIL RIDDERHOF.

Grand Rapids, Mich.

Wanted—Opportunity to learn the trade of blacksmith, machinist or carpenter. ——— ————, Vernon, Vt.

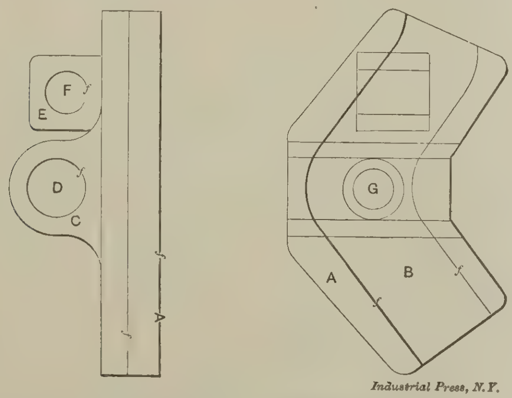
The young man who inserted the above "ad." in a Vermont paper a few weeks ago evidently does not feel quite sure what he was "cut out" for, but is willing to take a "whack" at any old trade. Perhaps he has expressed his preference in the order given, and, as Mr. Ridderhof intimates, if he does with his might what his hand is set to do he will win a certain degree of success in any one of the three trades. Nevertheless it seems too bad to make an indifferent carpenter out of a good blacksmith—or preacher. There is a vast difference between a mere inclination and a deep-seated instinct. The boy who has the mechanical instinct thinks "wheels," or constructive work of some kind. The fact remains, however, that to achieve success in any calling, mechanical or other, a degree of mental activity is required that impels a man to go ahead on his own initiative and not always wait to be told.—EDITOR.]

* * *

MACHINING A SEWING MACHINE "CROSSHEAD CAM."

Editor MACHINERY:

In the accompanying illustration, Fig. 1, are shown top and side views of a small casting *A* with a milled cam slot *B* on one side, and the hub *C* on the other side, through which runs a hole *D*. There is also a lug *E* with a hole *F*. It is used in a certain type of a sewing machine, and is termed "crosshead cam." It is machined on the front, being faced off straight. The three sides of the cam slot *B* are milled out, and the holes *D* and *F* are drilled and reamed true to the cam slot. As the building of this type of sewing machine was a "special order," the market demand for which was uncertain, temporary tools had to be designed and made for it. By this is not meant tools of elaborate and expensive designs that will manufacture the goods at a minimum of cost, but tools that are quickly designed and made at no great cost and will produce the goods at a reasonable cost for manufacturing.



Industrial Press, N.Y.

Fig. 1. Crosshead Cam to be Machined—Full Size.

Figs. 2, 3, 4, 5, and 6 are the tools designed and made for the purpose. The first operation on the crosshead is the facing of face *A*. Fig. 2 shows top and side views of the fixture in which that operation is performed on four crossheads at one time. The fixture sits on the table of the milling machine with its tongue *J* fitting in the corresponding slot in the table; the body *A* is fastened with clamps and screws to the table. The crosshead castings Fig. 1 to be faced, fit in the fixture, Fig. 2, between *C C*, whose recessed angles correspond to the sides of the crosshead, and they rest on three supporting pins *D, D, D*. The fastening is done by the handle lever *F* being moved upward, thereby forcing the plunger *E* inwardly against the crosshead and fastening it between *C, C*, and *E*. A slight tap with a mallet on the face of the castings

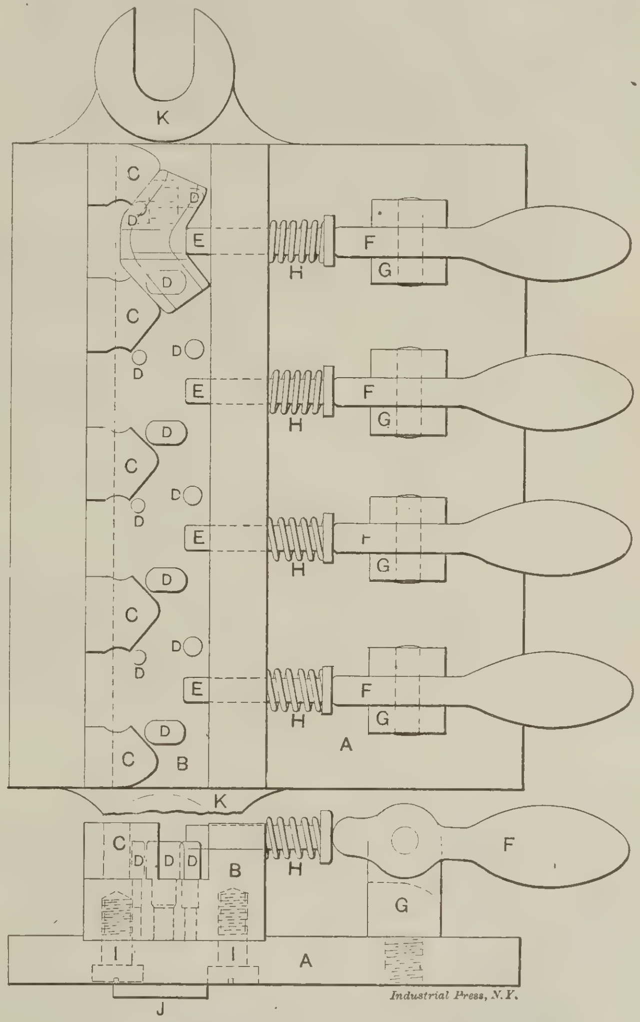


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Fig. 2. Jig Holding four Cams for Planing.

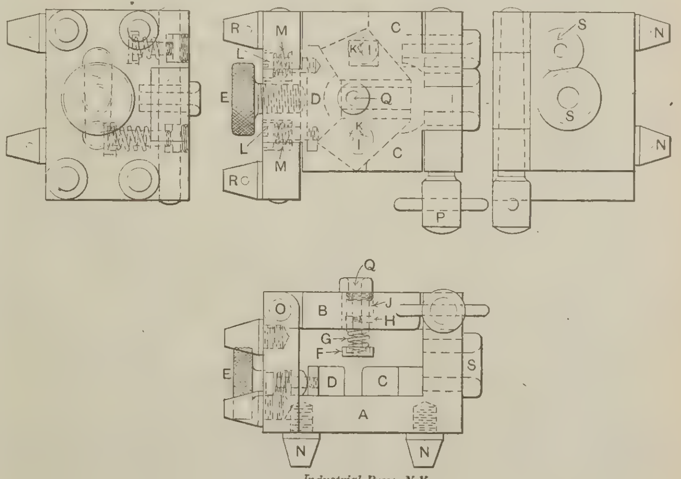

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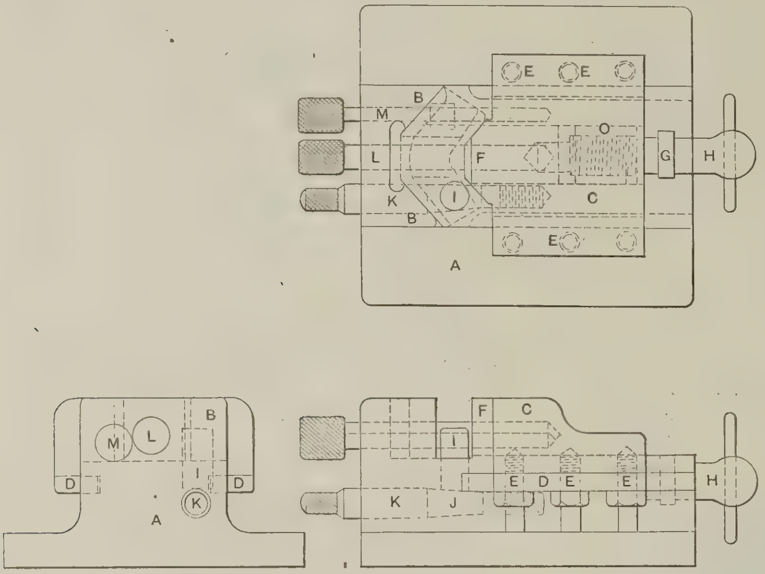
Fig. 3. Drilling Jig.

forces them down solidly on the top of the pins, and the four castings are easily and smoothly milled on their faces by a spiral-fluted cutter, when they are easily removed by pressing the handles *F* downward, thereby allowing the plungers *E*, actuated by springs, *H*, to move out and release the crossheads.

The next operation is the drilling of the holes *D* and *F*, and is done in the drill jig, Fig. 3. The taper pin *P* is withdrawn from the body A, and the lid or cover *B* that hinges on pin *O* is swung back, allowing the crosshead to be put in place with its milled face against the bottom of the jig and its sides against the sides of the steel piece *C*, *C*. The lid or cover *B* is then swung back in place and fastened by the insertion of taper pin *P*. It will be noted that under the cover *B* there are projecting two small plungers *F*, *F*, of about the shape of screws with large heads. The heads are recessed for the reception of springs *G* which give the plungers a downward tension. The bodies of the screws fit loosely in holes in the cover and have small round nuts *H* screwed on their ends to secure them from dropping out. The recesses *J* in the cover allow room for the up-and-down motion of the plungers, and the stop plugs *I*, which are screwed in the top of cover *B* with a little pin-wrench engaging the holes *K*, prevent the recesses *J* from getting clogged with dirt. When the lid *B* is turned back to its place and fastened by pin *P*, with the crosshead casting inside of the jig, the two heads *F*, *F* of the plungers pin down the crosshead on its face against the flat bottom of the jig. Then by the turning of the knob of screw *E* the steel piece *D* is moved forward and its side pressed against the sides of crosshead, gripping it tight between its faces and opposite faces *C*, *C*. The hole *G* in the crosshead is then drilled through the bushing *Q* when the drill jig rests on the legs *N*, and the holes *D* and *F* are drilled through the bushings *S S* while the jig rests on the legs *R*, *R*.



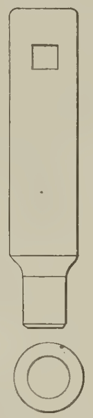


Fig. 6

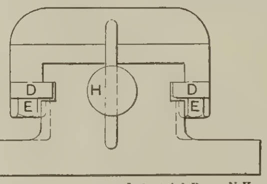


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Fig. 4. Jig for Milling Cam Slot.

Fig. 6. Guide Pin.

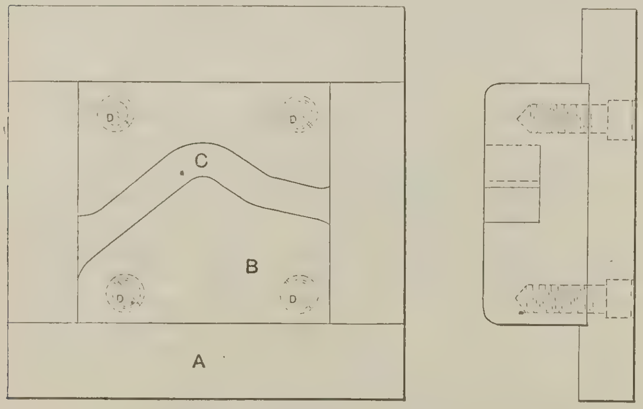

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Fig. 5. Master Cam or Guide Plate for Profiling Cam.

When the screw knob *E* is turned back the steel piece *D*, actuated by springs *M* on screws *L*, moves back, releasing the crosshead. The pin *P* is withdrawn, the lid *B* thrown back and the crosshead removed. It is then held between a wooden clamp and the holes are slightly reamed to insure uniformity in size of the holes *D* and *F*.

The casting is then ready for the milling of its cam groove *B*, which is done in a profiling machine, and is held in a fixture, like Fig. 4. This is a vise-like arrangement made entirely of steel. The body *A* has a jaw-like head *B*, *B*. A slide *C* attached to the body with two gibs *D* and screws *E* is moved by the screw *H*, fitting in recess *G*, and the threaded nut *O*. The crosshead, while it fits and is clamped between jaws *B*, *B* and *F*, first rests on and is lined up by the pins or plugs *M*, *L*, *I* and *K* in the fixture, to insure the milling of groove *B* in the crosshead being true with holes *D* and *F* and the face *A* in the crosshead. The desired result is attained by the pins *M* and *L* fitting nicely in the head *B* of the fixture, in the holes *D* and *F* of the crosshead, and in the corresponding holes in the slide *C*, and being parallel to the bottom of the fixture. This insures the true alignment of the crosshead. The vertical pin, *I*, fitting loosely in the hole in the fixture and resting on the taper part *J* of pin *K*, is for the purpose of providing a support to the body of the crosshead, against which it is pushed up gently, by turning the knurled end of pin *K*, purposely made of a small diameter for preventing the exertion of too much pressure and thereby springing the side of the crosshead upward, instead of merely providing a support for it when it is fastened between the jaws *B*, *B* and *F*.

The body of the fixture is fastened to the bed of the profiling machine with straps and screws, and the milling of the grooved cam is done by a spiral cutter fastened in one of the holders of the head of the profiler, while a pin like Fig. 6 is fastened in the other holder of the head, the end fitting nicely in a corresponding groove exactly like the one to be milled and a little longer at the ends. The groove is made in a steel fixture like Fig. 5, which acts as a guide for the motion of the profiler head holding the milling cutter that mills the cam groove in the crosshead Fig 1. In order to insure uniformity in the width of the grooves, and a smooth finish, the work had to be gone over twice with the cutter, which, however, was done quickly, as the cutter was run at high speed.

Newark, N. J. H. Robinson.

* * *

The owner of an extensive woodland tract in the Adirondacks has installed a steam wood-chopper for economically working timber valueless for lumber into small blocks for fuel. It takes whole trees, butt end foremost, and reduces them to blocks, splinters and shavings in short order. How many a farmer boy has sighed for something on this order to relieve him from the back-breaking bucksaw!

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only, and send sketches when necessary.

SIMPLE DRILL JIG.

The simple drilling jig shown herewith is in use at the W. F. & John Barnes shops, Rockford, Ill., and is adjustable so as to be adapted to pieces of different shapes and dimensions. The base piece *A* supports an upright *F*, to which the knee, *E*, is bolted. This knee is for the drill bushing and is tongued and grooved to the upright so that it may be raised or lowered for work of different heights. The work is held by two slides, *B* and *C*, and a setscrew *D*. The lower slide, *C*, has a tongue fitting in a groove in the base and one end is V-shaped to give support to the lower end of the work, against which it is made to bear. The slide, *B*, has a tongue fitting in a groove in the top of the lower slide, and may thus be adjusted independently of the latter.

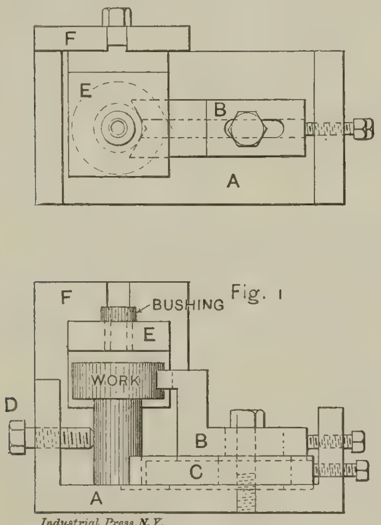

Fig. 1

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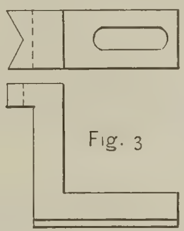


Fig. 3

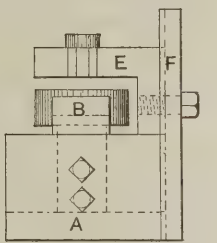
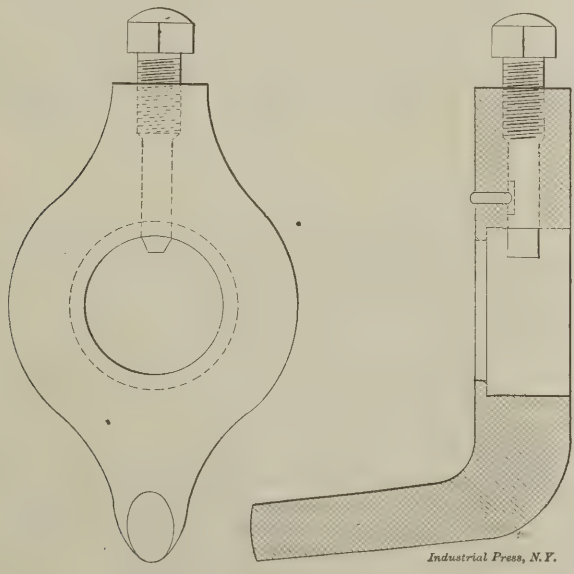


Fig. 2

STUD GEAR DOG.

I send sketch of a stud gear dog that I have used in the shop for several years. The dog is used on the pinions cut on the ends of shafts and I use four on my job here. The hole for the pinion is bored to the same diameter as the outside diameter of the pinion but it is not bored clear through, a shoulder being left, as shown. The hole for the setscrew is drilled as usual, but is tapped only about half way through. A pin is turned to fit and its inner end is beveled to fit the tooth space of the pinion. The pin is kept from falling out by a screw or pin engaging a short keyway cut in its side.



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Nashua, N. H. A. A. LAURIAN.

DOG FOR HANDLING PLATES.

W. H. S. sends us a sketch of a dog which has been tried and found very successful for lifting cast iron plates of 150 to 200 pounds weight, and which may be attached to a trolley for moving the plates about. The load is held by friction and is released instantly when the plate is lowered to the floor. The jaws *E E* are lined with sole-leather, riveted on. In spite of the law which says that friction is dependent upon the pressure regardless of the area, it has been found best to make these jaws about 2 x 3 inches square, the reason being that the roughness of the castings cuts into the leather somewhat, affording a mechanical grip in addition to the friction. The arms *B* should be continued down, as shown at *D*, Fig. 2, so that the jaws *E* will not drop down out of position when the load is released.

Fig. 1

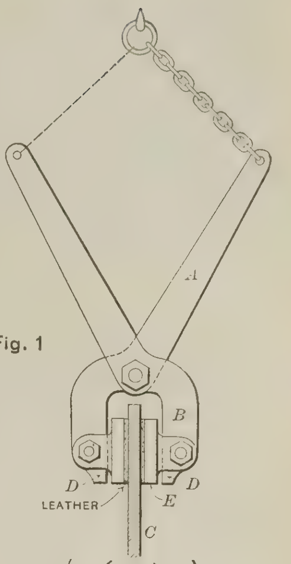
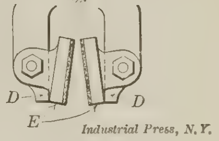


Fig. 2



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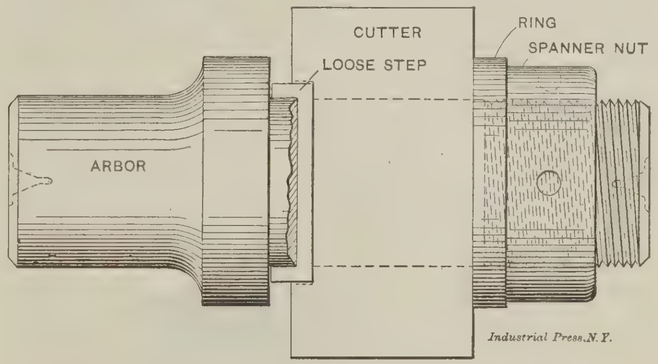
ARBOR FOR TURNING AND GRINDING BORING CUTTERS.

I have read in your journal descriptions of several shop kinks which we have found interesting and useful, and I have one that I wish to introduce to the readers. It is an arbor for turning and grinding boring cutters to exact size. The arbor is made of steel with deep hardened centers and has a slot to accommodate cutters of any size and diameter within limits. It is provided with a number of loose-fitting steps to suit the cutters from different boring bars. Between the cutter and the spanner nut holding it, is a steel ring or washer faced true on both sides so as to hold the cutter squarely in the arbor slot. This arbor is used by the New York Shipbuilding Co., Camden, N. J., and has been found to be an improvement over the old method of making and grinding boring cutters. H. G. NORDBY.



Industrial Press, N. Y.

Merchantville, N. J.

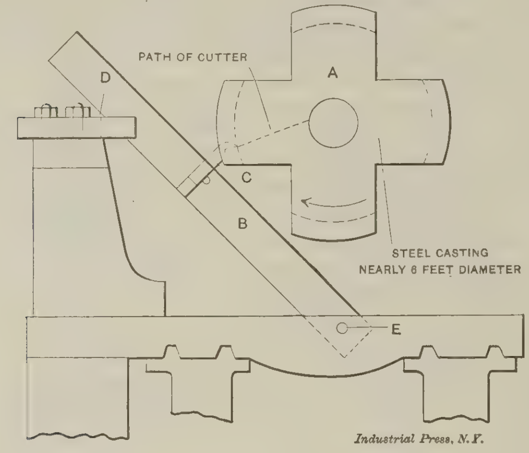
GRINDING A TAP TO CUT OVERSIZE.

Several years ago while employed in a shop that used a large number of studs we accumulated a kegful that were too large in diameter on the short thread end. Not having a tap large enough, they were rejected, but before we could get others there came a hurry job on which we had to use about sixty of the studs. The old trick of using a tin liner beside the tap made the hole too large, and wrapping the tap with waste did not make it large enough. In looking around for a way out of the difficulty I found an old stud tap that was very dull. It was no larger than the other taps, but after sharpening two adjacent lands of teeth, that is, sharpening the teeth of lands Nos. 1 and 2, leaving lands Nos. 3 and 4 dull, the tap worked to perfection, tapping the holes oversize just the desired amount. This may be an old trick, but I had never heard of it before, nor have I ever seen it used since. JOHN A. BURGESS.

Elmira, N. Y.

CUTTING-OFF TOOL USED ON SIX-FOOT STEEL CASTING

Cutting a steel casting, nearly six feet in diameter, in two in the lathe is a quite extraordinary job. The *Electric Club Journal* describes how a steel casting for a turbo-generator revolving field of this size was cut through in the middle. A special tool was rigged for the purpose and consisted of the ½-inch steel bar *B* carrying a cutter *C*. The bar was pivoted to the lathe carriage at the lower end at *E*, and the upper end rested against the inner edge of the tool rest from which, of course, the feed was taken. The cutter *C* was firmly keyed in the bar and moved toward the center of the casting in an arc of a circle, as the cross-slide fed inward. The casting *A* was mounted on a mandrel, and was rotated backward, thus requiring the tool to face downward. The reason for this was to prevent the chips crowding and interfering with the action of the tool. The cutter face was, of course, slightly wider than the bar so that the latter could follow into the cut as the center was approached.



Industrial Press, N.Y.

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DIMENSIONS FOR STANDARD JIG BUSHINGS.

In the design of drill jigs there is little save experience and judgment to guide the draftsman when determining the dimensions of the drill bushings. This often results in having bushings for the same size of drill, made with widely varying dimensions as to length and outside diameters. If, on the other hand, some standard is adopted and adhered to, uniformity will be insured and the toolmaker can make up bushings in leisure moments, knowing that they will be available whenever a rush job of jig work comes along. "E. W. D." has contributed the two accompanying tables of dimensions of bushings, which are now in use by a large manufacturing concern and furnish an excellent guide for any draftsman designing jigs where no standard has been adopted.

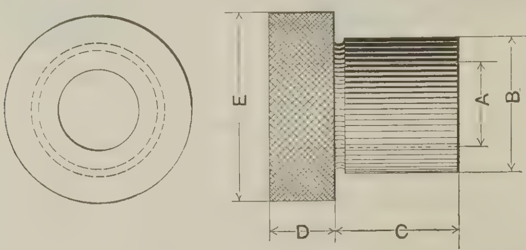

TABLE 1. DIMENSIONS FOR STANDARD FIXED JIG BUSHINGS.

Size Drill. A	B	C Short.	C Med.	C Long.	D	E
60	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{32}$	$\frac{5}{16}$
$\frac{3}{16}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{32}$	$\frac{7}{16}$
$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{32}$	$\frac{5}{8}$
$\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{3}{4}$
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{7}{8}$
$\frac{9}{16}$	$\frac{13}{16}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{1}{8}$	1
$\frac{5}{8}$	$\frac{7}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{5}{32}$	$1\frac{1}{16}$
$\frac{3}{4}$	1	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{5}{32}$	$1\frac{3}{16}$
$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{16}$	$1\frac{5}{16}$
$\frac{15}{16}$	$1\frac{3}{16}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{3}{16}$	$1\frac{7}{16}$
1	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{1}{4}$	$1\frac{1}{2}$
$1\frac{1}{16}$	$1\frac{5}{16}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{3}{8}$	$\frac{1}{4}$	$1\frac{9}{16}$
$1\frac{1}{8}$	$1\frac{7}{16}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{3}{8}$	$\frac{1}{4}$	$1\frac{3}{4}$
$1\frac{1}{4}$	$1\frac{5}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{3}{8}$	$\frac{1}{4}$	$1\frac{15}{16}$

Table 1 gives dimensions for bushings which are to remain in the jigs permanently and in making these bushings the external diameter given in the column B would be made a driving fit in the hole in the jig. Table 2 gives dimensions for removable bushings and in this case the outside diameter would be made a light sliding fit in the hole. In both tables the column *A* indicates the size of drill for which the bushing is to be used and would be made from .003 to .005 inch larger than nominal size.

TABLE 2. DIMENSIONS FOR STANDARD REMOVABLE JIG BUSHINGS.

Size Drill. A	B	C Short.	C Med.	C Long.	D	E
60 to 40	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{9}{16}$
40 to 26	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{3}{4}$
26 to 1	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{3}{4}$
$\frac{7}{32}$ to $\frac{19}{64}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$\frac{3}{8}$	$\frac{13}{16}$
$\frac{5}{16}$ to $\frac{3}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{3}{8}$	1
$\frac{25}{64}$ to $\frac{7}{16}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{7}{16}$	$1\frac{1}{8}$
$\frac{29}{64}$ to $\frac{17}{32}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{7}{16}$	$1\frac{1}{8}$
$\frac{35}{64}$ to $\frac{39}{64}$	$\frac{7}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{7}{16}$	$1\frac{1}{4}$
$\frac{5}{8}$ to $\frac{11}{16}$	$\frac{15}{16}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$\frac{1}{2}$	$1\frac{3}{8}$
$\frac{45}{64}$ to $\frac{49}{64}$	1	$\frac{3}{4}$	1	$1\frac{1}{2}$	$\frac{1}{2}$	$1\frac{7}{16}$
$\frac{25}{32}$ to $\frac{7}{8}$	$1\frac{1}{16}$	$\frac{3}{4}$	1	$1\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$
$\frac{57}{64}$ to $\frac{15}{16}$	$1\frac{3}{16}$	$\frac{3}{4}$	1	$1\frac{1}{2}$	$\frac{1}{2}$	$1\frac{5}{8}$
$\frac{15}{16}$ to 1	$1\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{2}$	$\frac{1}{2}$	$1\frac{3}{4}$

* * *

BUCHOLTZ STEAM TURBINE.

Steam turbine construction has already assumed a considerable diversity of form, all of which are represented to yield good results. The subject is altogether somewhat mystifying and inclines the layman to think that the theory for flow of steam and its effect in reaction machines, is not well understood. It now appears that a machine built very much on the order of the steam siren (used in place of the steam whistle by marine vessels) makes an efficient motor. The Bucholtz steam turbine made on this principle consists of a series of brass disks, half of which are mounted on a shaft, the alternate half being fastened to the case. The clearance between the plates is a few thousandths of an inch. Concentric rows of holes are drilled in the plates. Those in the stationary plates are drilled straight through at right angles, those in the rotating plates being drilled through at an angle. The steam is passed from one end of the turbine to the other through the successive concentric rows of holes until it exhausts ordinarily through those nearest the shaft. By these reversals of pressure all end thrust is avoided. The direction of rotation is reversed by simply admitting steam in the reverse direction and exhausting through the row of holes next the periphery. A notable feature of this turbine is its simplicity. It is also very compact for a given power.

* * *

What seems a hopeful departure in the methods of educating apprentices has been initiated at the Manchester (Eng.) School of Technology. Instead of youths spending three or four evenings a week attending science classes, those aged 18 and upward, who pass a preliminary examination and are recommended by their employers, are placed in special classes and are instructed all day on Mondays for 8 months in the year, their evenings then being employed in preparing their home lessons for the next Monday's classes. A great waste of the students' time and energy is thus obviated. The fee is about $8 for the course, and the method generally adopted is for the employer to pay the apprentices' wages for the day spent at school, and the fees to be paid by the student. Monthly reports are forwarded by the school to the employers, who can thus check any abuse of the privilege. This action on the part of Manchester educational institutions and employers is typical of a movement which is spreading throughout Great Britain, and coupled with steady and consistent improvement in the equipment and organization of industry is one of the most encouraging symptoms the past year has presented.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

22. B. E. L.: We have some difficult jobs at times which no doubt would interest others. Do you charge for publishing anything of this kind?

A.—No charge whatever is made for publishing matter that appears in the reading columns of MACHINERY; on the contrary, we *pay* for all accepted contributions. We might add that where special photographs are required or it is necessary for the contributor to incur other expenses, we are quite willing to remunerate him additionally for same. Under such conditions previous arrangement should be made with us.

23. E. S.—What is the best chemical preparation to use for brushing axes, hatchets, etc., immediately after they have been hardened and then put against the fire to be tempered? The object of applying a preparation is to make the surface of the steel clean enough so that the color is visible as the temper is drawn.

A. Probably some reader of the paper can give you more information upon this than can we, but we would suggest the use of hydrochloric acid—in the proportion of about 1 to 20—such as is used in freeing boiler plates, or other rolled metal, from scale.

24. O. P. L.—What are the specific heat and the specific gravity of mineral cylinder oil, 600 degrees F. test?

A.—We are not able to supply the information desired, and refer this inquiry to our readers. The question was referred to Prof. R. C. Carpenter, of Cornell University, who states that while they have conducted some experiments on the specific gravity of oils, these experiments have not extended beyond those of 450 degrees F. test. They have not determined the specific heat of any of the oils. Prof. Carpenter adds that there are very few oils indeed that can be heated as high as 600 degrees F., the flash point of the best cylinder oils being about 550 degrees F.

25. G. H. R.: If the valves of a double reversing engine be correctly set with 1-32 inch lead and it is found that the link-block just strikes the end of the link when hooked in the backward motion, and in the forward motion there is ⅝ inch clearance, will it alter the lead if I equalize the throw of the link-block by shortening or lengthening the link hangers?

A.—The lead will be changed so little that you will scarcely notice it, but the best way to equalize the throw of the link-block is to lengthen or shorten the reach-rod connecting the reverse-lever with the tumbling-shaft. If the reverse-lever is directly attached to the tumbling-shaft, shift the sector rack or quadrant so the position of the links will be equalized. If you change the length of the link hangers it will probably affect the steam distribution somewhat and for that reason is unadvisable.

26. A. M.—I would like some reliable information upon the sizes of standard pipe taps at the small end.

A.—There is no standard followed by manufacturers of taps for the small end of pipe taps. By referring to Kent's Mechanical Engineer's Pocketbook you will find, under the heading "Wrought-iron Pipe," tables giving the exact dimensions of the taper threaded end of pipes of different diameters, which is in accordance with Briggs' standard; and this would be the *theoretical* size of the pipe tap also. *Practically*, however, the tap is made longer than this tapered portion. The small end of the tap would be somewhat smaller than the small end of the tapered portion of the pipe. One manufacturer, to whom we have referred this question, says it is their custom to continue the tap three or four threads beyond the theoretical smallest diameter, as given by Briggs' standard.

27. C. S.—Please explain the effect upon the speed of an engine, of increasing the weight of the governor balls. Is the effect the same with the inertia, pendulum and centrifugal governors?

Answered by F. H. Burton.

A.—In general, increasing the weights of any shaft governor makes the engine run slower; as, with the spring tension remaining the same, the heavier weight gives the centrifugal force required to balance the spring tension at a slower speed than lighter weight. This applies more particularly to a double-weight shaft governor. With a single-weight governor of the inertia type, adding weight to what may be called the heavy end will cause the engine to run slower for the reason given above. Adding weight to the light end will cause the engine to run faster, as this weight, in a general way, balances the heavy end.

28. J. A. C.—A 36-tooth, 12-pitch spur gear is required to mesh with an internal gear of 42 teeth, 12 pitch. Will the Brown & Sharpe regular spur gear cutter allow these gears to properly mesh, or will it require cutters of special form? and if so, why?

A.—Mr. Oscar J. Beale, of the Brown & Sharpe Mfg. Co., has replied to this inquiry, and we have asked him to contribute an article upon the subject of internal gearing which we hope may appear in the near future. Mr. Beale writes:

"A 36-tooth spur gear cut with a B. & S. regular cutter will not mesh correctly with an internal gear of 42 teeth. A spur gear running into an internal, develops epicycloid curves, and these curves interfere with ordinary involute teeth. In other words, a spur-gear tooth must have room to develop its own epicycloidal curves, inasmuch as it is solid and is in the way of any other solid that is on its own side of the developed curve.

29. L. W.—Does the momentum of a flywheel vary as its weight and velocity, or does the momentum more than double, say, by doubling the velocity, the weight remaining the same?

A.—The momentum of a moving body is its mass multiplied by its velocity, or mv. The mass of a body is its weight divided by 32.2 (a constant expressing the acceleration produced by gravity in a freely falling body in one second). Hence

$M = \frac{w\,v}{32.2}$ in which

M = momentum

w = weight

v = velocity (in feet per second).

But the *energy* of a moving body is expressed by the formula:

$E = \frac{1}{2}\,mv^2$ in which

E = energy

m = mass (weight divided by 32.2)

v = velocity.

Hence it follows that the momentum of a flywheel, or other moving body, varies directly as the velocity, but the kinetic energy (which makes a flywheel valuable as a power reservoir) varies as the square of its velocity.

30. E. L. W.—Please tell me how to make a flux for brazing sheet brass into linings, for brass-lined cylinder work. It is desirable to have the flux melt at as low a temperature as possible, and to leave the inside of the lining as free from rough spots as possible in order not to cut the plunger packing.

A.—We referred this to the American Gas Furnace Co., Elizabeth, N. J., who reply as follows. 1. The cylinder must be so formed that the hub joint comes together tight, both ends of the joint being true, so they will come together and touch along the whole length. 2. Dissolve powdered borax in water, so as to make a thin paste and mix with ordinary brass solder such as is ordinarily used for brazing brass. 3. Apply the dissolved borax *only* to the seam with a brush. 4. Cover the seam with the wet brass solder—a thin layer covering the joint. 5. Braze in a gas furnace, in either of two ways: A. Apply solder on the inside, and braze in a horizontal position, seam down, sliding the cylinder along over a good burner, directed upon the seam from below. B. Braze by flame from the top, seam up, solder applied on the outside.

The company add that if any of our interested readers will send them a cylinder ready for brazing they will do it with pleasure and report on the proper furnace to be used.

31. Apprentice: I often hear our toolmaker speak of different grades of steel as "fifty-point-carbon," seventy-point-carbon," etc. What do these terms mean?

A.—The suitability of steel for most mechanical purposes is determined by the percentage of carbon it contains; in almost all cases it is less than one per cent. and is expressed in decimals of one per cent. Thus "fifty-point-carbon" means that the steel contains 0.50 per cent., or one-half of one per cent. carbon. In other words in every one hundred parts one-half part is carbon. It is awkward to say "fifty-one-hundredths of one per cent. carbon," so the nomenclature by common consent has been shortened to that given above.

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32. A. R. B.—What is the change of weight of a volume of water, say 1 cubic foot, from 32 degrees F. to 212 degrees? 2. To what degree can water be compressed?

A.—The weight of water varies slightly with its temperature. At 32 degrees F. a cubic foot of pure distilled water weighs 62.417 pounds; at 39.2 degrees (temperature of greatest density), 62.425 pounds; at 100 degrees, 62 pounds; and at 212 degrees, 59.84 pounds. The volume corresponding to the change of temperature can be found very closely, according to Goodman, by the following empirical formula:

Volume at absolute temperature. T, taking the volume at 39.2 degrees F. or 500 degrees absolute as 1 $= \dfrac{T^2 + 250{,}000}{1{,}000\ T}$

Thus the volume at 50 degrees =

$$\frac{(461 + 50)^2 + 250{,}000}{1000 \times 511} = 1.0002368$$

Hence the weight of 1 cubic foot of water at 50 degrees would be 62.425 ÷ 1.0002368 = 62.41 pounds. 2. Water is slightly compressible; a pressure of 3,000 pounds per square inch reducing its volume about 1 per cent. The approximate formula by which the reduction in volume may be calculated, within limits, is as follows:

$$v = \frac{p\,V}{K} \text{ in which}$$

v = diminution in volume, in per cent.

V = original volume.

K = modulus of elasticity, taken to be 300,000 to 320,000 pounds per square inch.

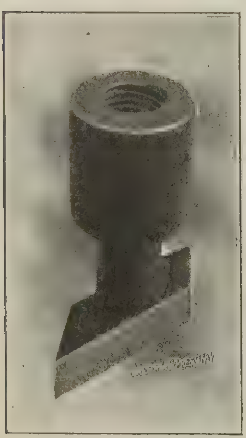
* * *

The piston blowing engine as applied to blast furnaces for the production of pig iron, was first used at the Carron Iron Works in England about 1760. Previous to this date huge bellows operated by hand, animal or water power, had been used. The Carron Iron Works blowing engine was driven by water power.

* * *

A STUD T-HEAD BOLT.

Below is reproduced the photograph of a T-head bolt which is intended to be a time-saver. It is drop-forged and case-hardened, and by reference to the cut it will be seen that the head is so shaped as to fill the T-slot, when given a half turn, and not slip. Where these heads are used for clamping work on machines it is only necessary to thread up any number of studs of any length in the bolt cutter and screw one end into the T-heads, the other end being threaded for the nut as usual. These heads are made of different sizes to fit all standard machines and are tapped for bolts ranging from ½-inch to 1⅛ inches in diameter. They are made by the G. R. Lang Co., Cincinnati, Ohio.

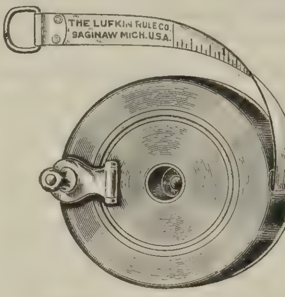


Lang T-head.

* * *

STEEL TAPES FOR MEASURING CIRCLES.

It frequently occurs that the easiest way to find the diameter of a pulley, drum, flywheel, tank or other circular object, is to pass a tape *around* it, measure the circumference and determine the diameter by dividing the circumference by the constant 3.1416. But if the tape were graduated so as to indicate diameters when measuring circumferences, there would be an obvious gain of time and convenience, to say nothing of eliminating the chance for error in calculation. To meet this want the Lufkin Rule Co., Saginaw, Mich., have brought out one style of their "Artisan" steel tapes which is graduated on one side in consecutive inches and 16ths and in diameter divisions on the opposite side. With this tape it is asserted that it is possible to measure within 1-64th inch of the actual diameters of pulleys, shafting, etc., by simply measuring the circumference. The tape is made of the best quality of steel, ⅜-inch wide, and is heavy enough to stand hard service. The case is nickel-plated and has flush handle for winding the tape into the case.



Lufkin Diameter Tape.

* * *

SIMPLICITY OF MOTOR DRIVE FOR MULTIPLE SPINDLE DRILL.

The Pratt & Whitney multiple spindle drill shown herewith has recently been equipped with individual motor drive, for use in the factory of the Emerson Electric Mfg. Co., St. Louis, Mo. It will be seen by the photograph that this makes a compact and simple arrangement. The tool was stripped of all countershafts, pulleys, etc., and a ½ horse power vertical Emerson motor securely mounted on the frame. A Renold silent chain drive is used for connecting the motor and drill spindles. These latter are equipped with ball bearings, which seemed advisable to reduce the amount of power required and to decrease the wear on the universal joints. This equipment enables the operator to turn out better and more work than before, the machine being much steadier. The company add that it is often a surprise to machine tool users and manufacturers to find how large a number of pulleys, belts, etc., can be dispensed with, even on small machines of this character, when motor drive is used. Fig. 2 shows the parts which were removed from this tool, for which the motor was substituted.

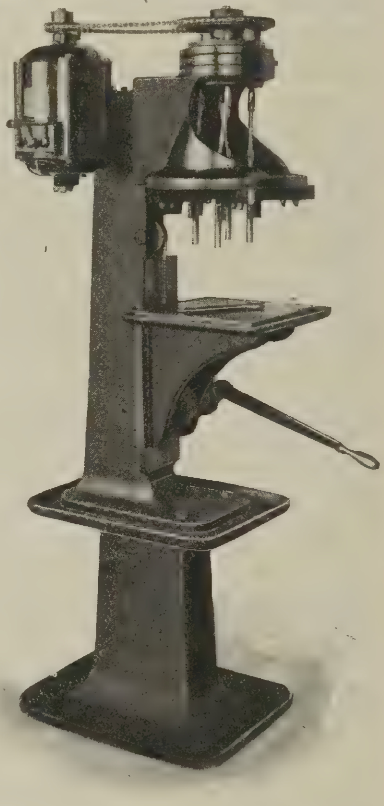


Fig. 1. Multiple Spindle Drill with Motor Drive

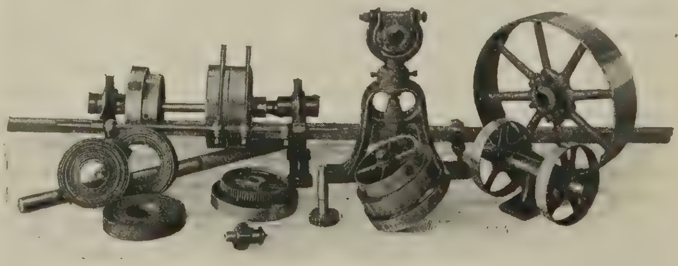


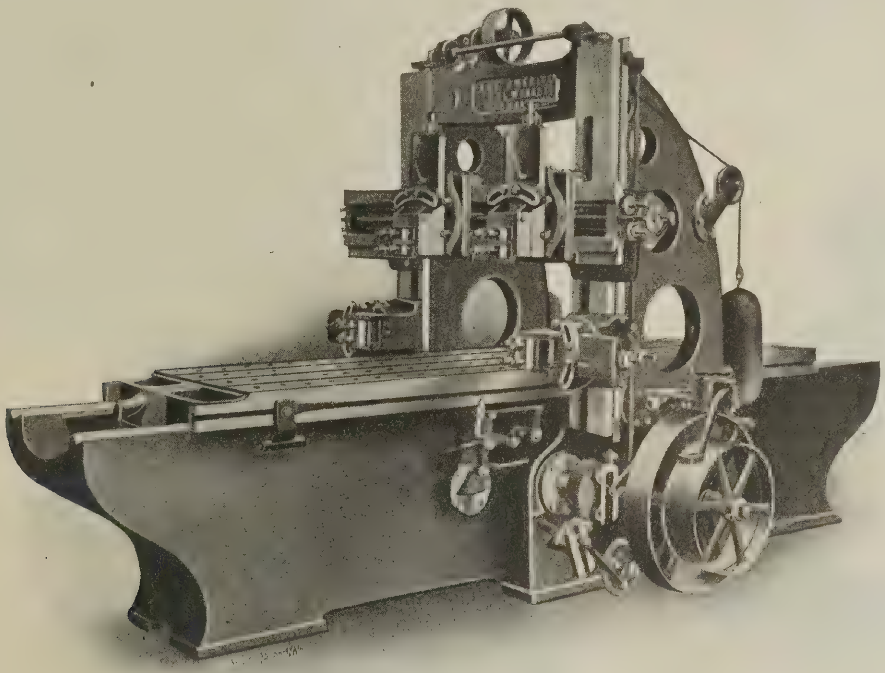
Fig. 2. Countershaft, Pulleys, Belts, etc., displaced by Motor Drive.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

IMPROVED METAL PLANER.

This machine has been built in order to meet the demand for a planer that will successfully resist the increased strains to which the modern methods of shop practice subject it. The bed is very deep, extending almost to the floor line, and has substantial legs cast integral with it. Heavy box cross girts at short distances give rigidity to the bed. The central portion where the strain is heaviest is strongly re-enforced. The table is of ample proportions, well braced by ribs, and is equipped with an improved dirt-proof feature; it also has quick return, reversing without shock or jar. The shifting mechanism removes the belt from one pulley before the other is engaged, obviating shrieking of belts.


American Tool Works Company's Planer.

The feeds are automatic in all directions and can be operated from either side of the machine. Side heads can be furnished, as shown in the illustration, or fitted after the machine is built, with slight modifications. The slides are so constructed as to permit planing at some distance from the housing. A separate feed mechanism is provided for rail heads and side heads. The action of this planer is said to produce very smooth surfaces, so that on work that must afterwards be scraped to a bearing the necessary scraping is reduced to a minimum.

This tool is built several sizes by the American Tool Works Co., Cincinnati, Ohio.

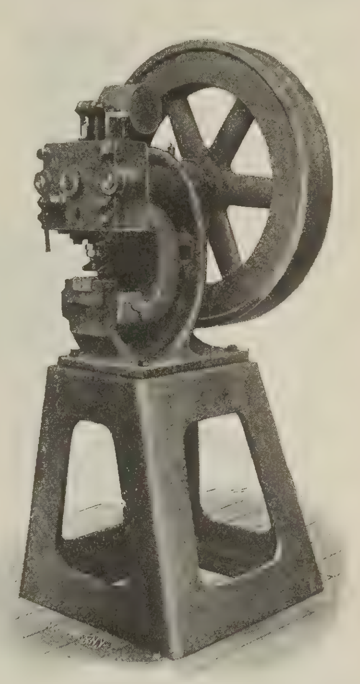
SMALL POWER PUNCH.

The punching machine shown herewith has been designed by the manufacturers, the Cleveland Punch and Shear Works Co., Cleveland, Ohio, for use in small boiler shops, blacksmith shops, and iron works where a low-priced tool is desired. In this machine the clutch mechanism has been done away with. The flywheel and shaft run continuously and by the use of an automatic gag which operates on the plunger only, this plunger can be stopped at any stroke of the tool at the highest point of its travel. The gag, shown on the front of the cover plate, is quickly and easily operated by the small lever, which throws out automatically, stopping the plunger. In this way the punch can be operated at a high speed without any shock or jar.

The punch holder and die socket are adjustable, and the die block of the machine is so designed that all kinds of structural shapes, bars, plate, etc., may be punched. Shearing tools can be easily substituted for the punching attachment.

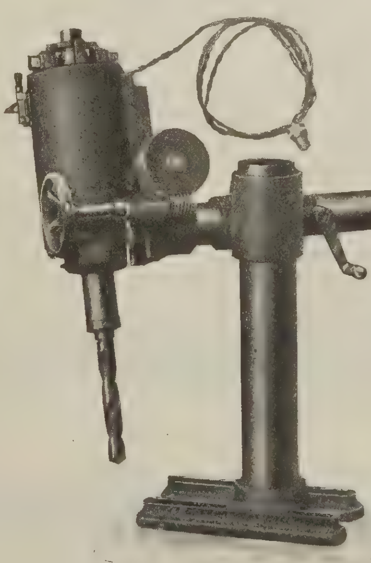
The cast iron base on which the machine is mounted may be dispensed with, and the punch mounted on a bench.

The maximum punching capacity of this machine is ⅝-inch hole through ⅜-inch plate, or ½-inch hole through ½-inch plate. Speed about 60 to 70 strokes per minute. The frame is of the solid "Cleveland" type.


Small Power Punch.

PORTABLE ELECTRICALLY-DRIVEN RADIAL DRILL.

The portable electric drill shown here has a capacity of 1¼ inch and is provided with a 10-inch feed through the handwheel, with a quick return by hand. It can be carried anywhere and used for inside and outside work. The driving power is obtained from any ordinary incandescent lamp socket.


Portable Electric Drill.

This drill has a radius of 24 inches in any direction and at any angle. The spindle is fitted with a ball-bearing thrust and carries a No. 3 taper socket. It has two speeds, by means of a thumb lever on the side, at the lower end of the motor.

It is also provided with a switch, to start and stop it, and the machine is under perfect control of the operator at all times.

The vertical and horizontal columns are made of hollow steel tubing. The base is in the form of a letter H, with suitable slots for clamping bolts. The gross weight of the drill is 210 pounds; height 30 inches over all. It is built by the Hisey-Wolf Machine Co., Cincinnati, Ohio.

SIXTY-INCH RADIAL WITH SPEED VARIATOR AND CONSTANT SPEED MOTOR.

A speed variator giving positive drive, with arrangement for change of speed, is now manufactured by the Dreses Machine Tool Company, Cincinnati, O., for use in connection with their radial drills. The illustration, Fig. 1, shows the variator attached to a 60-inch radial drill, which is designed to be operated by a constant-speed motor; and the outline drawing, Fig. 2, makes clear the principle of operation. The drill is made with the outside column swinging on an inside stump fixed to the base and reaching almost to the top. The clamping is done by a split band encircling part of the fixed stump and a flange at the lower end of the column turned to equal diameters. Driving of the drill spindle is done by a horizontal shaft near the base, a pair of miter gears and central shaft in the column, two spur gears on top of column and outside vertical shaft. This shaft carries a pair of miter gears and drives the upper shaft shown in the rear of the arm. Connection between this shaft and the shaft below, transmitting power to the drill spindle, is made by four friction gears operated by the adjustable handle rod shown below the arm and the handle attached to the arm. When the handle rod is in the central position the drill head mechanism stops; pushed to the right the spindle runs fast, without back gears, and pushed to the left, slow, with back gears engaged. By pushing the handle on the arm to the left, the spindle reverses to a fast speed, as the friction wheel making connections to the lower shaft is meshed indirectly by an idler journaled in the frame. By means of an adjusting screw on the operating lever the brake power can be regulated so as to avoid breakage of taps when over-strained or striking an obstruction. The power feed to the drill spindle is of the geared type, has six changes and is variated by shifting the knurled knob on the feed rod that controls a feather by which any desired gear is engaged.

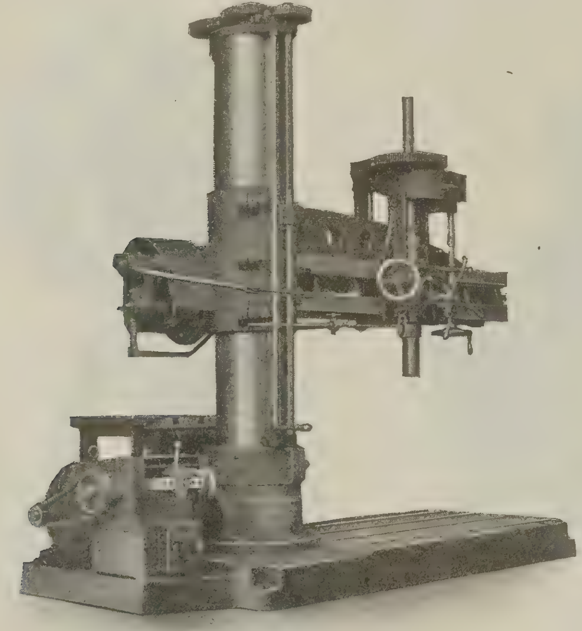


Fig. 1. Dreses Radial Drill with Speed Variator.

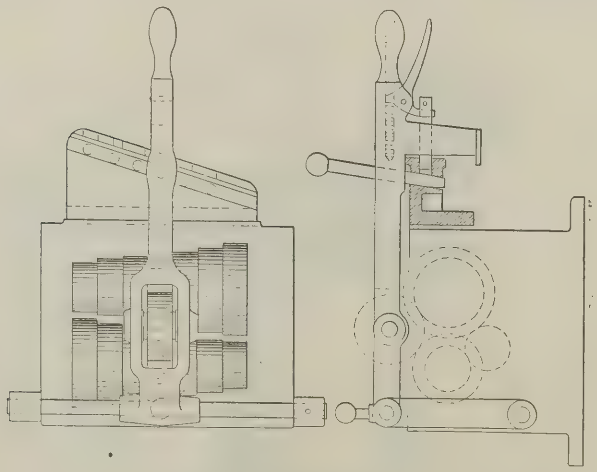
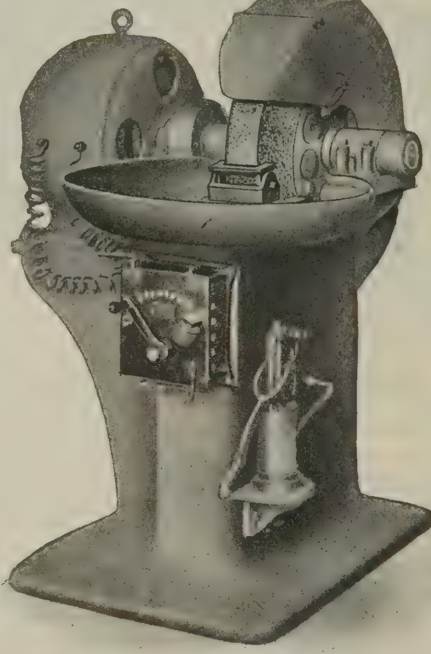


Fig. 2. Details of Speed Variator.

The speed variator has two shafts with seven gears on each, proportioned for seven speeds in geometrical progression, but not in mesh with each other. All these gears are fixed to their shafts, except the largest driven one on the variable speed shaft, which is connected by a pawl and ratchet arrangement. Connection between this ratchet gear and the smallest gear on the driving or constant speed shaft is formed by an idler pinion causing the driven shaft to run always at the slowest speed. When the speed of the variable speed shaft is increased the ratchet fixed on this shaft runs ahead of the pawl in the loose gear. The lever with handle shown in front of the speed variator swings in the rear on a bridle, carries a gear forming connections between the different gears on the two shafts, and is shiftable lengthways. The latch with plunger below the handle locks the handle vertically and the knobbed pin horizontally, all as shown diagrammatically in Fig. 2. The holes for locking in the index plate are drilled to suit the correct positions of the intermediate gear in mesh with the cone gears. No engagement can be made unless the intermediate gear is in the correct position. Though the inertia from rest to the different speeds has not to be overcome, as the variable speed shaft runs always at the slowest speed, the shock from low to high speeds proved to be still too great, and a frictional connection between the drill shaft and variator had to be introduced. This friction is similar to a planer feed friction and is adjusted to carry the heaviest load of the drill, but slips when taxed beyond this.



Bridgeport Motor-driven Water Tool Grinder.

MOTOR-DRIVEN WATER TOOL GRINDER.

The Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., have recently applied motor drive to their water tool grinders in what is proving a very satisfactory manner. A bracket is cast onto the side of the base and a Crocker-Wheeler motor is bolted on the bracket and direct-connected to the emery wheel spindle by a coupling which, when unbolted, allows the emery wheel spindle to be taken out easily for putting in a new wheel. This arrangement makes a positive drive without the use of bolts or chains and the machine is self-contained. Wheels on this class of machines run at a somewhat slower speed than the ordinary emery wheel, and this is arranged for by having a specially-wound armature to meet the requirements of speed for the different sizes of wheels that are used. The machine is equipped with knife switch and starting box with no-voltage release, and also has a speed regulator to increase the speed of the wheel as it wears away, thus giving the same cutting speed when the wheel is half worn out as when it is new. The grinder itself is provided with water reservoir and air pump connections for applying the water to the wheel in the manner that was described and illustrated in the July number of MACHINERY. These grinders are manufactured in four sizes for carrying wheels 20, 26, 36 and 42 inches in diameter.

SMITH & MILLS SHAPER.

The illustration, Fig. 1, shows a new design of shaper built by Smith & Mills, Cincinnati, O., who have made a specialty of shapers for the past sixteen years. The chief feature of the design is the compact speed-changing device, or mechanism, by which the operator can readily change his speeds without stopping the machine or removing any of the parts.

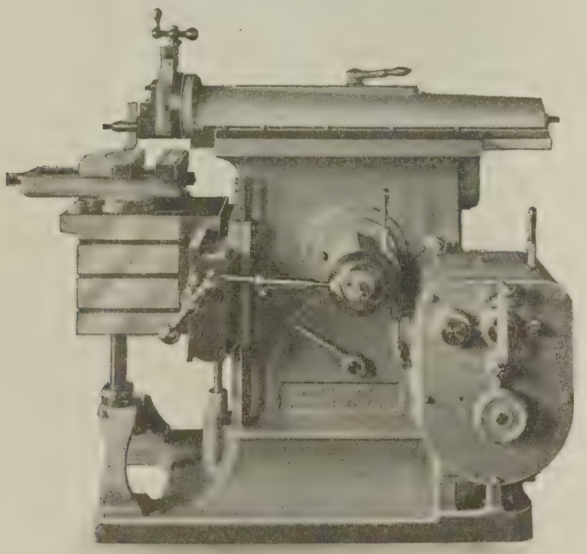


Fig. 1. Smith & Mills Shaper, with Speed Changing Device.

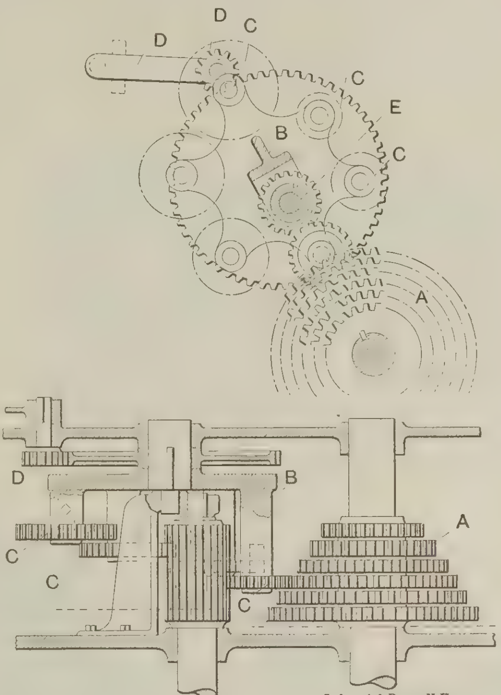
The speed box is very compact, resting on the base and attached securely to the side of the column. It contains all the gears and parts required to perform its work, the main features being a cone of gears, a driving pinion and a revolving carrier having arms to which are attached idle pinions. These couple alternately the driving pinion and one of the gears on the cone shaft. The cone shaft engages the bull wheel which operates the crank and gives motion to the tool head.

In the line drawing, Fig. 2, *A* is the cone of gears; *B* the carrier, on which are the intermediate pinions *C C C*, etc. The carrier is rotated by a pinion *D*, which is operated by a crank, so as to bring any one of the pinions into position between the cone and the main pinion *E*.

The main driving shaft runs through the box and column with a bearing on the rear side; beyond this are the tight and loose driving pulleys. One revolution of the crank in either direction changes the position of the carrier from one arm to another and thus changes the speed.

The lever seen protruding from top of box is to connect the back or compound gears. The lever between the box and the central shaft in column is for starting or stopping the machine. There are 8 specific changes and 64 variations of stroke.

In designing this drive care has been taken to make it convenient and durable and to have it appear as a component part of the machine. The gears are of drop forged steel and the pinions of best quality of gun metal, insuring solidity and lasting qualities. This all-gear arrangement makes the machine powerful, adapting it for use of the high speed cutting steel now in vogue. An advantage of this drive is that no matter at what speed the tool is cutting, there is a uniform tension on the driving belt. It does away with cone pulleys and shifting belts, and lessens the liability of injury to workmen. It also provides an ideal drive for motor connection by using a plain and simple constant-speed motor.



Industrial Press, N.Y.

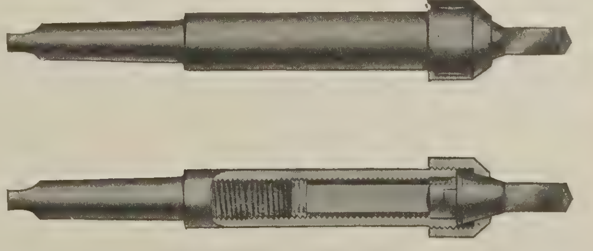
Fig. 2. Sectional View of Mechanism.

The illustration shows the device attached to a 20-inch crank shaper, but the same device is made suitable for various sizes from 12 to 24 inches stroke.

The shaper is provided with wide flat bearings with adjusting gibs and large journal bearings. A patent wristpin used for changing the stroke, allows the stroke to be changed without stopping the machine. Opening under the ram admits shafts of any length for key seating. There are micrometer dials on the vertical feed and cross screws, for cutting racks, key seats and division work. The eccentric feeding plate is drilled to correspond with the ratchet wheel, dividing the space so that an even tooth is fed at all times.

THE RICH DRILL CHUCK FOR FLAT DRILLS.

The drill chuck shown in the accompanying illustrations is designed for the economical use of high-speed steel for flat drills. No blacksmith work is required, the chuck being so constructed that no forging is necessary as the machinist can shape the drill from the flat bar by grinding. The chuck consists of a long sleeve into one end of which is screwed the shank which is made standard Morse taper so as to fit any drill press, and at the other end of the sleeve is the collet for holding the flat drill. The interior of the sleeve is threaded for nearly its entire length and a threaded plug fitting therein is provided having a slot in which fits the shank end of the drill. By engaging the end of the drill in the slot the plug can be turned in or out of the sleeve so as to accommodate the drill to the depth of the hole to be drilled. This is an important feature of the chuck since the length of the drill



Drill Chuck for Flat Drills.

need never be more than that necessary for the depth of the holes being drilled and in this way the maximum stiffness of the drill is available for the work in hand. A bushing is fitted in the lower end of the sleeve to center the drill, the bushing being changed to accommodate different size drills. A slot is milled across the lower end of the sleeve in which are fitted lugs on the jaws to prevent the drill turning in the chuck. Over the jaws is fitted the tapered and threaded sleeve for compressing the jaws.

The chuck is made in a variety of sizes for drill presses, and small size chucks are made specially for use on air motor drills by the George R. Rich Mfg. Co., 171 South Canal St., Chicago, Ill.

PLATE STRAIGHTENING ROLLS.

The accompanying cut illustrates a machine designed for straightening plate for boilers, tanks, safes, structural work and all other purposes. The machine has nine rolls arranged in two tiers—five rolls in upper tier and four in the lower. The upper series of five rolls are adjustable vertically, to suit thickness of sheet to be straightened. The outer rolls of this series are adjustable independently, by means of worm and worm wheel. The three inner rolls are raised and lowered together and arrangement is provided whereby all the upper rolls may be adjusted, after being once set, without change in their relative positions.

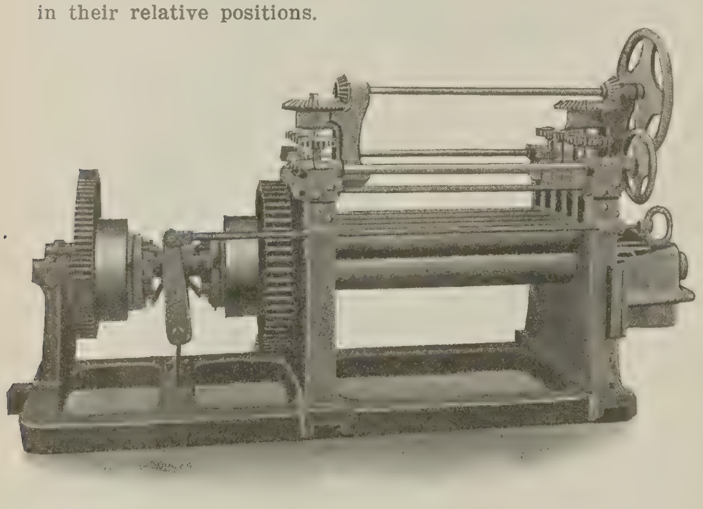


Plate Straightening Rolls.

The lower series of four rolls are all geared together by means of steel pinions. The outer ends of these rolls are supported in a bracket, which also supports the idler pinion. All the rolls are made from steel forgings, amply heavy to prevent spring.

The driving gears are heavy and the ratio of gearing is such that the friction clutch pulleys, with which the machine is provided, are able to do the work easily.

As will be seen in the cut, the rolls are mounted in heavy housings, having wide journal bearings. The machine is self-contained, as all stands and housings are mounted on a heavy bed plate. This obviates the necessity of extensive foundations.

This machine is built by the New Doty Mfg. Co., Janesville, Wis., and the makers claim for this machine that only the best material and workmanship enter into its construction and that it is a most efficient tool and does its work in a perfectly satisfactory manner.

GRINDER FOR SPECIAL WORK.

A special grinding machine is now made by the Heald Machine Company, Worcester, Mass., for grinding piston rings, thrust collars, disks, cutters and any thin circular work that is to be ground on its sides. The machine was primarily designed for grinding piston rings, but it has been found well adapted to a great variety of other similar work which is now being done on expensive universal grinding machines and which may be finished as accurately and quickly on a machine of less costly construction.

Inasmuch as piston rings are really double-seated check valves it is important that they fit the grooves nicely, and it is known that a considerable saving in steam or gas consumption can be effected by having the rings so fitted by grinding.

The machine consists of a Walker magnetic chuck 8 inches in diameter mounted on a vertical spindle with micrometer adjustment. The grinding wheel is mounted in a cross slide which can be fed across the work by means of the handwheel shown, or an automatic power cross feed will be added if desired. An adjustment is provided with the upper part of the column so that the machine can be made to grind hollow or crowning at the center of the chuck. This latter feature is of value especially in grinding metal slitting saws which need to be thinner at the center for clearance.

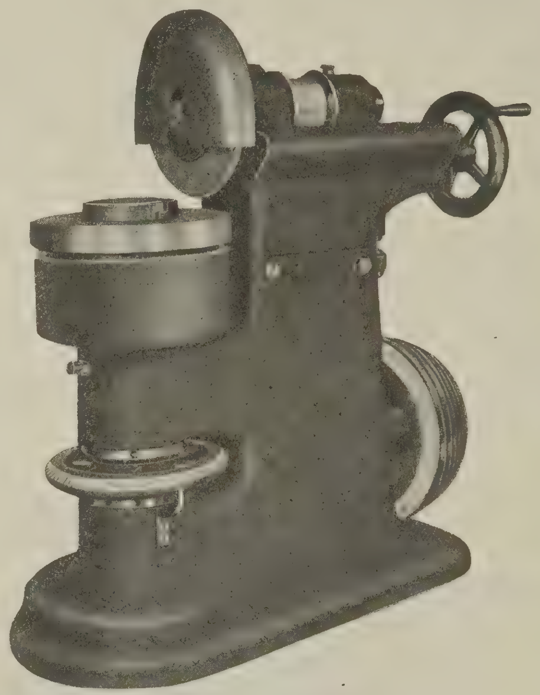
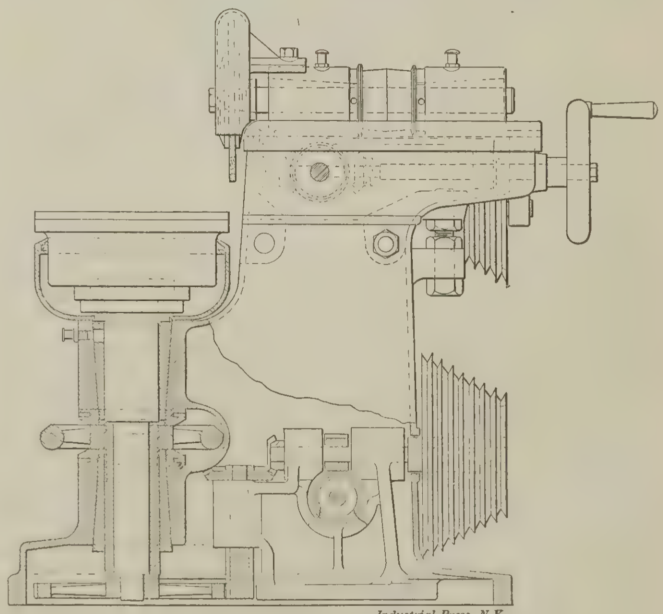


Fig. 1. The Heald Grinding Machine.

The machine is thoroughly built, with adjustable taper bearings as shown in the line drawing, and the wheel for adjusting the vertical feed is graduated to thousandths, and finer if desired. Dust caps are provided for the bearings. The cone pulley which drives the work has eight grooves, enabling the operator to obtain the best speed. The magnetic chuck is particularly convenient for the class of work that is accomplished by the machine, because nothing can be simpler than turning on or off the current, which at once either releases or clamps the work on the faceplate of the machine.



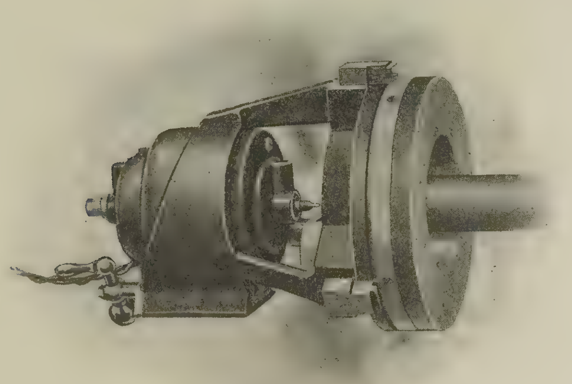
Industrial Press, N.Y.

Fig. 2. Sectional View of Grinder.

PORTABLE CENTERING MACHINE.

A light, portable device for centering shafting, round and hexagon stock, etc., has been brought out, as shown by the accompanying cut. The machine consists of a universal chuck fitted to a frame (in the present instance composed of an aluminum compound) at the opposite end of which is a motor, with a drill and countersink aligned with the center of the chuck. The motor travels in a gibbed slide and is operated by a feed screw and handle, causing the drill and countersink to enter the end of the bar. Wear is taken up by means of slides and set screws, at the base of the casting. A stop across the inside of the chuck opening prevents the drill point from being brought into too sudden contact with the end of the bar, through careless handling.

The machine weighs only about 25 pounds. It is 10 inches long and the outside diameter of chuck is 8 inches. Its capacity is for bars up to 4 inches in diameter, which it is not necessary to square up on the ends before centering. Inasmuch as the device is easily carried to the work, and derives its power from any electric light fixture, it obviates the necessity for moving a heavy bar to the centering machine or for centering it in the old-fashioned way in the lathe. It is the invention of Mr. Frank H. Hudson, Room 704, 110 State Street, Boston, Mass., and while it is not yet manufactured regularly for the market, it is intended to make it in different sizes for both large and small work.



Portable Centering Machine.

A NEW LINE OF MACHINISTS' TOOLS.

The Sawyer Tool Co., Fitchburg, Mass., have brought out a number of new tools, among which are machinists' steel clamps in sizes from 1¼ to 2¾ inches opening, a cross level, an adjustable bench level, a machinists' scriber, etc. The machinists' clamps and the cross level are illustrated herewith. The machinists' clamps, Fig. 1, are of steel, and case-hardened. The screws have a ball and socket bearing upon the jaws, thus eliminating all unnecessary strain from the threads. They are made in three sizes.

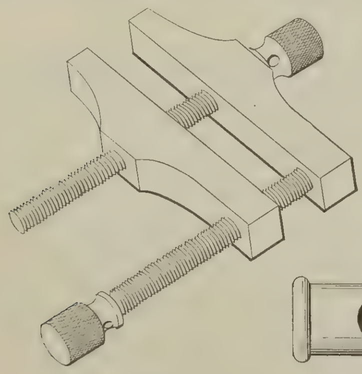
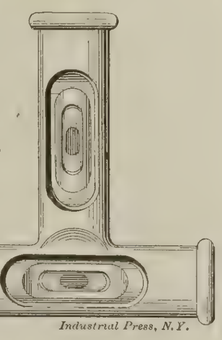


Fig. 1.



Industrial Press, N.Y.

Fig. 2.

The cross level, Fig. 2, is also neatly enameled, with polished ends, and is particularly useful in quickly leveling up work. It is 2½ by 3 inches by ⅝ inch.

The new scriber, which is not shown here, has a knurled body, to enable the tool to be firmly held. The marking points are of tempered crucible steel, and are held in the body by a taper fit which insures firmness and yet allows them to be removed when necessary. Its length over all is 8 inches.

CAM FEED DRILL.

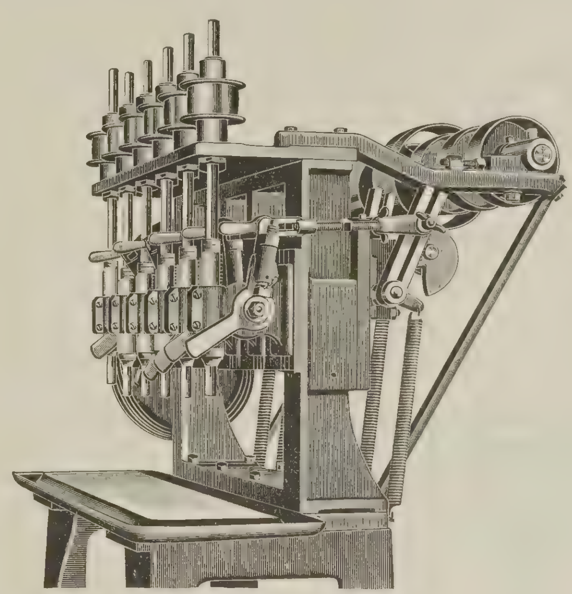
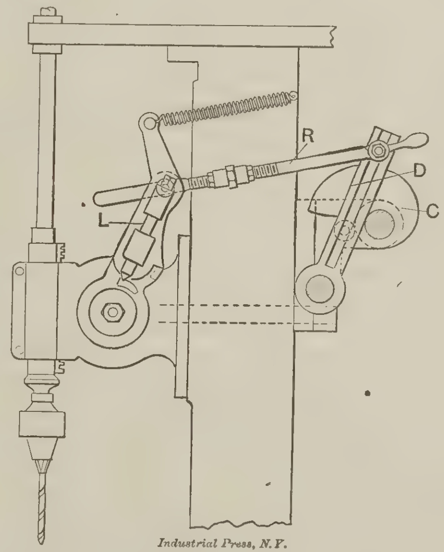


Fig. 1. Cam Feed Drill.



Industrial Press, N.Y.

Fig. 2. Detail of Drill.

An automatic cam feed drill for manufacturing purposes is a late production of the Dwight Slate Machine Co., Hartford, Conn. Fig. 1 shows a 6-spindle drill of this type, and Fig. 2 illustrates the details of the mechanism. The advantage of a cam feed is that the cam may be laid out to give a more rapid feed at the start than toward the end of a hole, so that the drill will be fed more slowly after it has reached a considerable depth, at the point where it is to break through the metal. In Fig. 2, *C* is the cam, which gives the feed motion to the spindle through the connecting rod *R*, the lever *L*, and the familiar pinion and rack connection. Inasmuch as a cam has a certain definite throw it would ordinarily be necessary to provide a new cam for each change in depth to be drilled, unless the drill were allowed to run for a greater or less length of time without doing any work on the metal. To provide against this contingency a slotted lever connection *D* is provided, which lever is driven directly by the cam and consequently has a positive throw. It is slotted its whole length, however, and the pin of attachment for the connecting rod *R* at this lever can be clamped at any point along the length of this slot. By this means the travel of the feed mechanism for a single rotation of the cam may be made a greater or less amount and still the kind of motion given to the drill—that is, rapid at first and slow at the end—will remain the same whatever the depth of the hole. A turnbuckle is provided on the connecting rod *R*, in order that the travel of the drill may be correct in relation to the work. A patented safety stop is also provided, by making the lever *L* in two parts. The lower member is locked to the pinion shaft and the upper member, which pivots upon the lower, is held in alignment with the latter by means of a spring pin or latch which locks into a recess on the lower member. If overload occurs the pressure of the cam will break this connection before there is sufficient strain to break the drill.

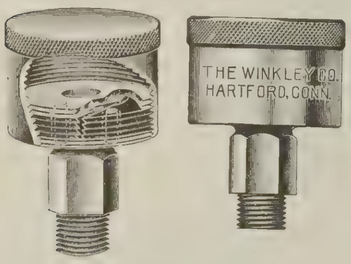
It will be noted from Fig. 1 that the cams are placed on a shaft at the rear of the machine. These cams are so timed that they operate in succession, and by timing the rotation of the shaft in accordance with work to be done the feed can be adapted to the ability of an operator to tend the machine, and also to the character of the work to be performed.

The connecting rod *R* has a hook connection with the lever *L*, Fig. 2, so that it may be easily disconnected by hand and the spindle moved independently of the feed motion.

IMPROVED RATCHET GREASE CUP.

The cut herewith shows the improved "Crown" grease cup manufactured by the Winkley Co., Hartford, Conn. It contains a split, threaded packing ring, held in the base of the cup, upon which the cap is screwed. When the cap is screwed on, the slot in the packing ring closes, thereby giving a pressure against the cap which prevents any grease from working out and gathering dust, making the cup unsightly.

Another feature is that the split ring acts as a check in unscrewing the cap. The ring always tends to expand, and presses outward against the threaded portion of the cup sufficiently to prevent the latter from shaking off when the cup is attached to rapidly running or vibrating machinery. It is also found that the threads of this cup wear much longer than in the ordinary cup having a solid threaded portion.



The Winkley Oil Cup.

These cups are manufactured in seven sizes, ranging from ¾ inch to 3 inches inside diameter.

The D. E. Whiton Machine Company, New London, Conn., have brought out a centering machine of special design for accurately centering shafts 5 inches in diameter, or smaller, which have been previously finished. To accomplish this the work is held in two centering chucks, one of which revolves and acts as a driver.

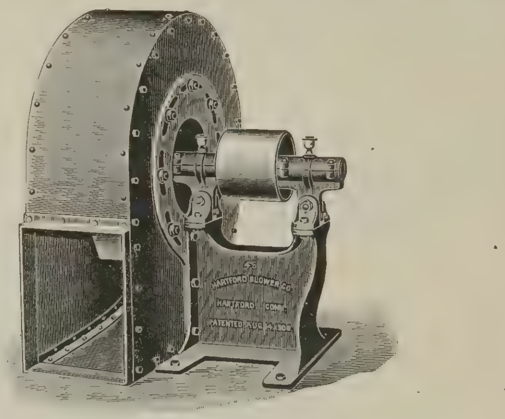
The shaft is firmly gripped in the revolving chuck, while the end near the tools is supported and revolved in the jaws of the stationary chuck, as in a lathe center rest. The centers may then be drilled and reamed to the required depth by the drilling and reaming tools which revolve in a direction opposite to the work and at different speeds. In this way the tools produce centers which exactly correspond with the surface of the stock. When so centered, such shafts may be turned to receive pistons, pulleys, gears, etc., which may be mounted as accurately as upon fully turned shafts, and a large amount of turning may be dispensed with. The product of the turret lathe may also be conveniently centered and afterward perfectly finished by grinding.

The spindle mechanism, headstock and 3-jaw centering chuck used in this new machine are similar in design, but heavier than those used in their regular two-spindle centering machine, and the machine is of heavier design throughout.

THE HARTFORD FANS.

The Hartford adjustable exhaust fans are a recent production of the Hartford Blower Company, Hartford, Conn., and possess original and valuable features not contained in non-adjustable fans. The construction is such that over twenty different styles are combined in one machine. As will be clear from the engraving, the casing for the fan is adjustable upon the frame supporting the bearings, and the fan may be placed upright on a floor or suitable foundation, or it may be reversed and bolted direct to overhead timbers, saving the cost of an expensive platform.

All machines are interchangeable. Right-hand machines may be changed to left-hand or *vice versa* at any time, either as upright or suspended machines. The discharge outlet may be adjusted to point in any desired direction at will. Upright or suspended machines may be adjusted equally as conveniently. After using the machine in one position for a time, it may be adjusted for a new position, in order to comply with altered arrangements. While the advantages of these machines are many to the consumer they are particularly appreciated by the dealer, who is able to meet the demands of the trade by carrying a much smaller stock than he would ordinarily carry. Both single and double machines are built, for a large variety of purposes. The housing is of steel plate of such thickness as to withstand the abrading action of the material. A heavy iron pulley standard attached to the housing carries the Hartford patent improved continuous oiling boxes.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HARTFORD BLOWER CO.
HARTFORD CONN.
PATENTED AUG 14 1900
Hartford Exhaust Fan.

* * *

One of the features of the new plant of the B. F. Sturtevant Company at Hyde Park, Mass., peculiarly indicative of the permanent character of the new works now under construction, is the steam tunnel 4½ feet in width, and 6½ feet high, extending from the power plant to the most remote part of the manufacturing buildings, a total distance of about 800 feet. This tunnel, which is of concrete construction, will not only accommodate all of the steam piping, but also the electric wires for power, light, telephone, standard time clock, and other service, together with oil, hot water and other pipes for general distribution to the various buildings of the plant. None of these features of the equipment will be carried above ground at any outdoor point. While the expense of such an installation is necessarily large, the convenience of access for changes and repairs will in the future much more than offset any fixed charges thereon.

* * *

SUMMARY OF NEW TOOLS, CATALOGUES, ETC.
IN THIS NUMBER.

MACHINERY describes in each number more new tools and appliances than any other mechanical paper, and a glance over this column will enable the reader to pick out what is of special interest to him.

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1. It secures for your enquiry careful attention from the manufacturer and prompt adjustment by the publisher of any just complaint.
2. It enables the manufacturer to trace the results of his advertising.
3. It ensures MACHINERY just credit for the good it has done the advertiser.

FRESH FROM THE PRESS.

THE *Patternmaker* for April—the second number of a new journal published by the Iron and Steel Press Co., Cleveland, O., contains 40 reading pages. These are devoted to the following interesting and instructive subjects: "The Pattern Department of the Stilwell-Bierce & Smith-Vaile Co.," illustrated by a large number of half-tones; "Gearing and Gear Patterns," by H. J. McCaslin, a very comprehensive article on this subject; "Pattern Shop Arrangement; Pattern Costs," by R. W. McDowell, and an article on the band saw, showing how the teeth of bevel gear wheels can be sawed out on the band saw and also how a number of other interesting things can be done with it. There are also articles on "A Handy Saw Table," "The Growth of Trees," by Prof. M. J. Golden, with several photographic reproductions of sections of wood; "How to Make a Patternmaker," by Mr. A. J. White, of Akron, O.; "A Cement Chuck," and several other short articles, as well as notes and news of the past month. Sample copies of this interesting journal will be sent upon application.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

THE BUFFALO FORGE CO., Buffalo, N. Y. Pamphlet illustrating the Buffalo "B" volume blowers and exhausters.

THE HARTFORD BLOWER CO., Hartford, Conn. Catalogue No. 56, treating of steel plate blower and exhaust fans.

THE CINCINNATI PLANER CO., Cincinnati, O. Wall hanger illustrating the Cincinnati planers, and views of the shops of the company.

THE CRANDALL PACKING CO., Palmyra, N. Y. Price list of the "Crandall" packings for steam, ammonia and hot and cold water.

J. L. GARD, Denver, Colo. Leaflet illustrating a handy woodworkers' vise, with a swivel jaw, and opening 15 inches. For further information, address J. L. Gard, 1616 Blake Street, Denver, Colo.

THE CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 35 illustrating and describing the installment of the Crocker-Wheeler system in the new railway shops of the Lake Shore & Michigan Southern Railway, at Collinwood, O.

THE LUCAS MACHINE TOOL CO., Cleveland, O. Descriptive circular of the No. 2 "Precision" boring, drilling and milling machine. A very fine half-tone view of this machine appears, together with a description of its special features.

THE GOODELL-PRATT CO., Greenfield, Mass. Circular calling attention to the hacksaw blades manufactured for use in power machines. The No. 300 heavy hacksaw blade and the No. 500 extra heavy hacksaw blade are shown and prices given.

THE LAIDLAW-DUNN-GORDON CO., Cincinnati, O. Bulletin L-508, an illustrated pamphlet fully explaining the features of the improved Cincinnati air compressor. The pamphlet will be sent upon application to any one interested in air compressing machinery.

FRANK A. SIMONDS, consulting steam engineer, Grand Rapids, Mich. Booklet entitled "Steam Receivers and Separators," which treats of the advantages of the "Simonds" improved steam receiver and separator. This booklet will be sent to anyone interested.

ERNST G. SMITH, Columbia, Pa. Leaflet illustrating the "Columbia" calipers. These instruments have hardened jaws and are warranted accurate and satisfactory. The "Which Way" pocket level is also shown. This leaflet will be sent to any one interested.

THE AMERICAN TURRET LATHE MFG. CO., Warren, Pa. Three circulars illustrating and describing respectively the 6 x 48-inch, the 22-inch and the 24 and 27-inch semi-automatic turret lathes. These lathes are powerfully built and if desired may be fitted for electric driving.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Folder treating of Dixon's graphite pipe joint compound, which comes in 4-ounce collapsible tubes that may be carried in the pocket or tool bag, for use on screw joints of every sort, pipe fittings, flanges and faced connections.

THE KNOWLES STEAM PUMP WORKS, New York. Illustrated catalogue, K-104, specially devoted to pumping machinery for beet sugar factories. The different sizes and styles of the "Knowles" steam pumps are here illustrated and described and some interesting information given regarding the beet sugar industry.

THE NEW JERSEY FOUNDRY & MACHINE CO., New York. Illustrated catalogue of the "Coburn" system of trolley tracking, for use in mills, foundries and machine shops, etc. These tracks are built for light and heavy loads. A number of views show the "Coburn carrying track" in operation in a machine shop, a cotton mill, railway repair shop, etc.

THE ERIE ENGINE WORKS, Erie, Pa. Circular calling attention to the engines and boilers manufactured. These include automatic, stationary, detached, double portable, semi-portable, combined agricultural and return-flue portable engines; and stationary, portable, "Columbia" and vertical boilers.

THE EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Catalogues Nos. 2660 and 2670 of electric motors. The former treats of the Emerson fan motors for alternating current and describes several styles for desk and ceiling use. This is handsomely illustrated. No. 2670 deals exclusively with the Trojan alternating fan motors.

THE W. F. & JOHN BARNES CO., Rockford, Ill. Catalogue No. 61 of drills and machine tools. These are produced in many sizes and styles for light and heavy work. Upright drills are shown, also a 20-inch gang drill, and the No. 1 horizontal radial drill. These tools are belt-driven, but can also be arranged for electric drive, if desired.

THE S. R. SMYTHE CO., Pittsburg, Pa., represented in New York by Dr. Oskar Nagel, 90 Wall St. Catalogue on "suction" gas producers for gas engines, showing the simplicity and advantages of the construction and the economy in fuel attained thereby. These producers are built in units from 5 to 150 horse power and yield 1 horse power hour per pound of coal. No boiler or gas holder is required.

THE CLING-SURFACE MFG. CO., Buffalo, N. Y. Leaflets containing testimonials from prominent firms here and abroad regarding the satisfactory results obtained from the use of Cling-Surface on troublesome belts. One letter, received from the Tokio Electric Light Co., Tokio, Japan, reads in part as follows: "We beg to state that Cling-Surface is giving most satisfactory results for high-speed belting. We have no hesitation in highly recommending it."

THE B. F. STURTEVANT CO., Boston, Mass. Catalogue No. 115, second edition, 1904. This particular catalogue treats in a concise manner of the Sturtevant Co.'s forges, blowers, exhausters, countershafts, blast gates, galvanized iron work, disk and propeller fans, and of engines, dynamos, motors, generating sets, steam heating, ventilating and drying apparatus, etc. Its pages present the essential types of these products, with lists of sizes and important features.

THE STANDARD PRESSED STEEL CO., 20th and Clearfield Streets, Philadelphia, Pa. Illustrated pamphlet, February, 1904, describing the American "Pioneer" pressed steel shaft hanger. This is made entirely of open-hearth steel, pressed to shape. One of the claims for this hanger is maximum strength with minimum weight. Different views of the company's products are given: Drop hanger, floor stand, post hanger; also side and sectional views of the bearings.

THE COOPER HEWITT ELECTRIC CO., 220 West 29th Street, New York. Catalogue descriptive of the Hewitt mercury vapor lamp, a description of which recently appeared in MACHINERY. This can be put to a number of uses: In offices, machine shops, drafting rooms, store houses, factories, etc., and the company claim that the light is soft and not trying to the eyes, owing to the almost entire absence of the red rays, and that the cost is much less than for other systems of lighting.

THE EDGECOMBE CO., Indianapolis, Ind. Circulars and price list of "Red Cross" cement for the cementing of pipe joints. The company claim that not only will this compound make a joint tight, but that it prevents rust, so that the joint can readily be taken apart at any time. It is intended for screwed-joint work and service with water, steam, gas and air, and the company state that it is not affected by heat, acids, alkalis, superheated steam or electricity.

THE C. W. HUNT CO., West New Brighton, N. Y. "Industrial Railway" catalogue, just issued. This book is very complete, contains a large number of illustrations showing the many and varied types of cars, standard and special, built for all purposes of transportation. Also the tracks and switches adapted to the various styles and sizes of cars. An electric locomotive, for hauling loaded cars, also appears. Considerable information on the subject of industrial railways is to be found here.

THE AMERICAN MACHINERY CO., Grand Rapids, Mich. Illustrated catalogue of the Nos. 2, 3, 5 and 6 "Oliver" wood trimmers. These four sizes are shown by half-tone views, and quite a complete description of the principle of the "Oliver" trimmers is given. Also pamphlets describing and illustrating the "Oliver" universal saw bench, the "Oliver" hand planer and jointer and the "Oliver" band saw, type B—a line of new tools in which the company think readers will be interested.

THE AMERICAN BLOWER CO., Detroit, Mich. Catalogue No. 159, devoted exclusively to the subject of brick drying by the use of the "A B C" waste heat drying apparatus. This book contains 77 pages devoted to information regarding this system, and to illustrations of the kilns, steel plate fans and engines used. A table giving the capacities of the various sizes of standard steel plate fans at varying revolutions, and one giving capacities of these fans at varying pressures, and other useful tables also appear.

THE DIAMOND MACHINE CO., Providence, R. I. Illustrated catalogue, 1904, of Gorton disk grinders. Herein are described and shown the universal and plain disk grinding machines manufactured, in many sizes and styles, for working on plain surfaces and for circular work in great variety. Some of these machines are belted and others electrically driven. Some space is devoted to a line of vertical spindle grinders—several half-tones and line cuts showing the construction of this type of machine—and samples of the work turned out on the "Gorton" grinders also appear.

THE G. A. GRAY CO., Cincinnati, O. Illustrated catalogues, recently issued, of planers. These are of two distinct types, the spur-geared planers and the spiral-geared planers. They are built in a variety of sizes, and furnished with any of the following electric drives: On the spur-geared planers, direct-connected drive, silent chain-geared drive and motor-belted drive: on the spiral-geared planers, self-contained drive and the motor-belted drive. The planers are built in any length of bed, with single or double heads on rail, and side heads on either one or both housings.

J. H. Williams & Co., Brooklyn, New York. Illustrated catalogue, 12th edition, 1904, of drop forgings. This contains a description of all the drop-forged specialties carried in stock, including several which were added to the company's line during the past year. They call attention to their external gage forgings, and to the internal gage forgings which are made to correspond in size and design with the external forgings; also double-head hexagon box wrenches. The catalogue is very tastily gotten up and contains a large number of illustrations. Several pages illustrate special drop forgings which are not carried in stock, but show the character of the work done. These forgings are made of iron, steel, copper, bronze and aluminum.

The Brown & Sharpe Mfg. Co., Providence, R. I. General catalogue, 1904, of machinery and tools. This catalogue has been thoroughly revised and contains 482 pages. The principal additions for this year are given in a colored insert, in which special attention is also called to their line of milling machines which is very complete and embodies new features of importance and value; also to their new method of indexing (which is now applied to their universal milling machines) to their very full line of machinists' tools, etc. The book contains a large number of useful tables and other valuable information, besides a very complete index. This catalogue is mailed upon application to any address without charge, or is furnished by hardware and supply dealers.

The B. F. Sturtevant Co., Boston, Mass., announce that the second edition of their catalogue No. 115 is now ready for distribution. It describes and illustrates a number of new apparatus among which are: A new type of hand-blower; several new types and sizes of forges; new sizes of vertical single and double engines; a new type of enclosed vertical compound engine; new type of semi-enclosed bi-polar and 4 pole motors; new sizes of generating sets with vertical compound engines; factory equipments, such as bench-legs, pattern storage shelf brackets, electric hoists, cast-iron sinks, trench cover-plates, etc.; industrial railway equipments, such as cars, truck ladles, turntables, T-rails, etc. It also contains a description of the various Sturtevant systems, such as heating and ventilating, special ventilating, drying, conveying and mechanical draft systems.

Hammacher, Schlemmer & Co., New York. Catalogues Nos. 1223, 1224 and 1225. The first of these shows a miscellaneous assortment of tools and supplies used in the shipping rooms of large warehouses, in factories, apartment houses and office buildings, with a brief description of each. No. 1224 treats of saws and saw sets exclusively. Herein are listed hand saws, gage saws, miter-box saws; back saws; dove tail, joiner and plumbers' saws; pruning saws, the "Little Giant" pruning hook and saw, compass saws, keyhole saws, turning saws, coping saws, and a number of saw sets for various purposes. The company also carry a full line of circular saws, saw vises, hack-saw blades and frames, files, swages, etc. Catalogue No. 1225 deals with planes exclusively. This is very complete, illustrating a great variety of planes for all possible purposes. The two catalogues on saws and on planes are new departures in this line, separate catalogues for these tools not being generally issued by tool houses. A discount sheet for each of these catalogues has also been issued.

MANUFACTURERS' NOTES.

The Detrick & Harvey Machine Co., Baltimore, Md., have informed us that their plant was not damaged in the great Baltimore fire.

Mr. Frank H. Hudson, the inventor of the portable centering machine described in another column of the paper, desires to correspond with concerns or individuals interested in reference to putting the machine on the market. His address is Room 704, 110 State St., Boston, Mass.

The Warner & Swasey Co., Cleveland, O., have secured the services of Mr. David Hunt, Jr., formerly for several years with Manning, Maxwell & Moore, but recently Treasurer of the Baush Machine Tool Co., Springfield, Mass. Mr. Hunt has taken the position of general sales manager for the Warner & Swasey Co.

The Oesterlein Machine Co., Cincinnati, O., have sent us a copy of a testimonial letter received by them from the Darling Pump & Mfg. Co., Ltd., which reads, in part, as follows: "Having tried for fifteen years all the various makes of friction clutches, we feel that there is nothing that comes anywhere near the Oesterlein for durability and efficiency."

The Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa., have sent us a copy of their revised price-list No. 22 of their "Elephant" brand phosphor-bronze. The company state that their new rolling mill is now in successful operation, and with greatly increased facilities and a well-assorted stock of manufactured goods on hand they are now able to fill orders promptly.

The American Machinery Co., Grand Rapids, Mich., inform us that Mr. A. N. Spencer, for 25 years with J. A. Fay & Co., and later with the J. A. Fay & Egan Company, has joined forces with Mr. Oliver in the American Machinery Company. Mr. Spencer has a thorough knowledge of woodworking machinery. The company contemplate enlarging their plant; new machines are to be constructed which will be high grade in every respect.

The Rand Drill Co., New York, report that there has been a large increase of sales in their "Imperial" pneumatic tool department since the first of the year. Orders have also been received for their piston air drills, wood boring machines and hammers; and they have installed a number of complete pneumatic tool plants in railroad shops, ship yards, boiler works, foundries and bridge and iron works in this country and abroad.

The American Tool Works Co., Cincinnati, O., inform us that they have purchased manufacturing rights under several patents pertaining to speed-changing devices. These patents, they believe, give them the undisputed right to build, without fear of patent infringement, their improved "American" engine lathe with quick changing mechanism for thread cutting and feeding. The line of sizes in which this lathe is built ranges from 14 to 36 inches swing inclusive.

Joseph V. Woodworth, 57 Tompkins Avenue, Brooklyn, N. Y., who will be remembered as one of our contributors on the subjects of dies and sheet metal work, has opened an office at the above address, where he is prepared to give advice as a consulting mechanical expert on the treatment of steel, special machinery, dies, molds, jigs and fixtures for interchangeable manufacturing, etc. A copy of his "Booklet A" will be sent to any address on application.

The Burt Mfg. Co., Akron, O., announce among recent orders, the following: The Jones & Laughlin Steel Co., a 30-inch exhaust head for their plant at Pittsburg; the American Shipbuilding Co., Lorain, O., an order for Cross oil filters; a cable order from Paris, France, for a large shipment of Cross oil filters; an order from a large plate-glass factory at Alexandria, Ind., for three 16-inch exhaust heads.

Hammacher, Schlemmer & Co., New York, have placed on the market a new product in the shape of a setscrew having a hexagon socket in the head for the application of the wrench and which is threaded the full length. This construction makes it possible to turn the screw in flush with the surface, or below it, and it obviates the great danger attending the use of the square head setscrew on revolving shafts, etc. One length of screw is all that is required for any depth of hole. For further information we refer to the advertisement in this issue.

H. W. Johns-Manville Co., 100 William Street, New York have just placed on the market a new fireproofing material, "Ceilinite," for fireproofing ceilings in electric cars, for which purpose it is being used by the Pennsylvania Railroad Company and the Interborough Rapid Transit Company. It may be used also for lining partitions, side walls, etc. It is made in pieces ⅛ to ⅜ inch thick, 36 inches wide and about 50 feet long. Samples can be obtained from the manufacturers in New York, Milwaukee, Chicago, St. Louis, Boston, Philadelphia, Pittsburg, Cleveland, New Orleans and London.

Bartz, Wygant & Brown, Hornellsville, N. Y., have designed a 10-inch portable electric bench drill for light, rapid drilling up to ¼-inch holes. It has five changes of speed, and the table can be raised or lowered, or swung to either side and locked in any position. The bearings are self-oiling and require little attention. The principal dimensions of this drill, are: Greatest distance from spindle to table, 9 inches; vertical adjustment of table, 6½ inches; table diameter, 8 inches; distance from center of spindle to frame, 5¼ inches. It weighs 100 pounds.

The H. W. Johns-Manville Co., 100 William St., New York, announce that they are placing on the market a material for which they have adopted the trade mark of "Niagrite," for preventing loss by fire and danger to life from the short-circuiting of high-voltage electrical wires. It comes in strips of several widths from 3 to 36 inches and is held in place with asbestos fire-proof glue, thus protecting the cables from external fire and confining the internal fire. The material has been adopted by a number of prominent concerns. Full particulars may be obtained from the Asbestos Department of the Johns-Manville Co.

The Hartford Blower Co., Hartford, Conn., announce the following recent orders: "Hartford" exhaust systems for the Oak Duke Lumber Co., Wellsville, N. Y., and for the Pennsylvania Match Co., Bellefonte, Pa., a third order for an exhaust system from the L. S. Starrett Co., Athol, Mass.; an order for twenty-four Hartford patent improved cyclone dust collectors; an order for an exhaust system from the Ivor Johnson Arms & Cycle Works, and one from the American Emery Wheel Works. The Hartford Co. design and give estimates free of charge on exhaust systems of all kinds, as well as heating, ventilating and mechanical draft apparatus, and all letters, inquiries, will receive prompt attention.

The Norman W. Henley Publishing Co., 132 Nassau Street, New York, have just issued a 40-page pocket catalogue of their up-to-date scientific and practical books, including and fully describing such works as "Dies, their Construction and Use," by J. V. Woodworth; "Mechanical Movements, Powers, Devices and Appliances," by G. D. Hiscox; "Modern Machine Shop Tools," by Wm. H. Van Der Voort; "The Modern Machinist," by John T. Usher, and many other practical works indispensable to the machinist, mechanic, electrician, etc. This catalogue will be sent free to anyone requesting it, and every progressive machinist or practical man should have it. We advise all our readers to write to-day for a copy of it.

W. H. Coverdale & Co. have recently been incorporated to do a general engineering and contracting business, with offices at 66 Broadway, New York. Their organization includes engineers of experience in all matters relating to the design and construction of steam and electric railroads, lighting and power plants, coal and ore handling machinery, etc. Mr. Coverdale was for many years in the engineering department of the Pennsylvania lines west of Pittsburg, and was Track Elevation Engineer of that company in Chicago during 1898-99. He was also prominently identified with the construction of the Westinghouse shops at East Pittsburg, and for the last three years has been Civil Engineer for a New York firm of engineers and contractors.

The American Watch Tool Co., Waltham, Mass., have re-acquired from the Loop-Lock Machine Co. their former factory plant and all assets appertaining to the manufacture of watch tools, precision and automatic machinery, watchmakers' lathes and attachments. The company request, therefore, that all further communications in regard to above lines shall be addressed to the American Watch Tool Co., which title they have again assumed as a Massachusetts corporation. They take upon themselves the responsibility of liquidating all the indebtedness of the Loop-Lock Co., and desire, therefore, to receive early remittances of all accounts due. The company state that they are better equipped than ever before, with larger facilities for meeting demands.

Royal E. Burnham, patent attorney, Washington, D. C., has just gotten out a new and enlarged edition of an interesting booklet which contains much information concerning patents, trade-marks and copyrights. The booklet presents in a convenient and readily accessible form such information as will enable persons to proceed intelligently to secure letters-patent on their inventions, register their trade-marks and obtain copyrights. Among the subjects treated are what may be patented, the preliminary examination, cost of securing patents, the application, scope of applications, patentees, examination of applications, appeals, interferences, caveats, designs, opinions on validity and infringement of patents, patent litigation, value of inventions, etc. The booklet may be had for the asking upon application to Royal E. Burnham, 837 Bond Building, Washington, D. C.

PNEUMATIC TOOL LITIGATION.

A great many statements of different kinds have been made with regard to the pneumatic patent litigation, and in response to an inquiry we have been furnished the following information regarding the status of the Boyer patents as opposed to those of the Philadelphia Pneumatic Tool Co.: On June 24, 1901, Judge McPherson in Philadelphia rendered an opinion in favor of the Philadelphia Pneumatic Tool Co. and held that neither their hammer nor their handle infringed any claims of the Boyer patent. Judge Adams, of St. Louis, on December 20, 1902, declared the same handle claims of the Boyer patent invalid. The Chicago Pneumatic Tool Co. took an appeal in Philadelphia solely as to the handle, and on December 21, 1903, the Circuit Court of Appeals in Philadelphia reversed the Circuit Court merely as to certain handle claims. On January 13, 1904, the Circuit Court of Appeals in St. Louis, without a consideration of the merits, affirmed the opinion of Judge Adams, finding the handle claims Nos. 42 to 48 of the Boyer patent invalid. From the foregoing it will be seen that some of the handles in the Boyer patent have been found to be valid in Philadelphia and invalid in St. Louis.

Petition for rehearing has been filed in Philadelphia and steps will be taken to have the matter reviewed in the Supreme Court at Washington. There has been no injunction against any of the hammers of the Philadelphia Pneumatic Tool Co. of any nature whatsoever, any assertions to the contrary notwithstanding. The Chicago Pneumatic Tool Co., who were originally aggressors in this litigation, are likely to have their own tools enjoined, since five suits are pending against them as defendants, and it is believed that the hammer and hammer patents owned by the Philadelphia Pneumatic Tool Co. are being infringed by the Chicago concern.

In regard to the pneumatic tool litigation the Thomas H. Dallett Co., Philadelphia, Pa., assure their patrons that the recent decisions of the courts on pneumatic tool patents do not apply in any way to the Dallett tools. These tools are made under their own patents and buyers assume no risk of infringement or litigation in their purchase.

MACHINERY.

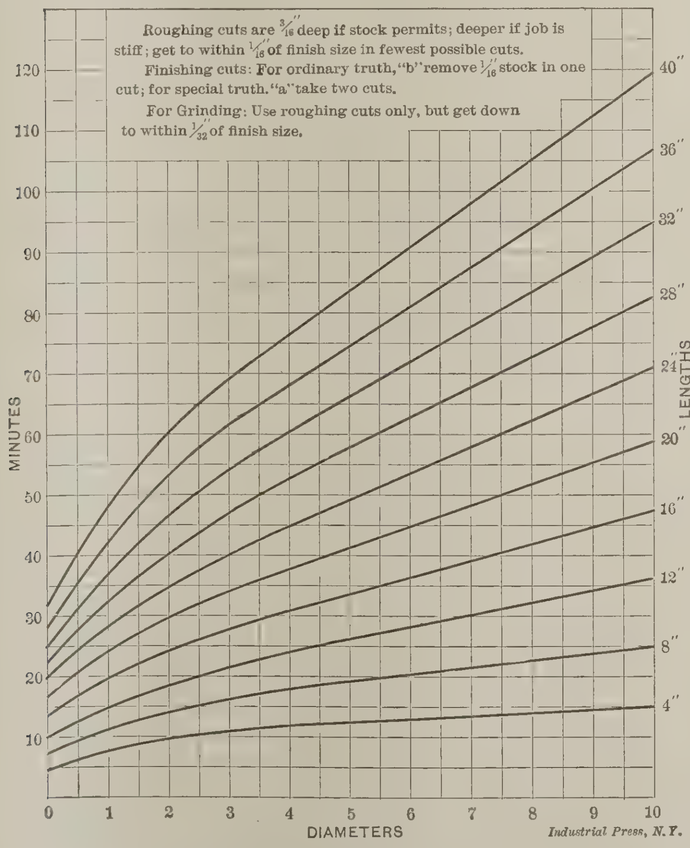
May, 1904.

ESTIMATING TIME FOR LATHE WORK.

HENRY HESS.

When called on to fix the price for a job the man who has this by no means agreeable duty, at once tries to recall some more or less similar piece within his experience to serve as a guide and precedent. Only when no such piece can be called to mind is recourse had to an analysis of the various operations to be performed and to estimating the time each is likely to occupy, from which the price to be offered the workman may be fixed. Then begins a course of bargaining, one side holding that the time was altogether underestimated, only to be met with the assurance that the most extravagant, unjustifiable and almost ruinous liberality characterized the estimate all through. Then, if the ratefixer is not a man of great tact and in possession of the good will and confidence of the men, these, in doing the work, will prove most conclusively that he was all "off"—as what proof could be more conclusive than that the job did take much more than the estimated time? "For ways that are dark and tricks that are vain," not only "the heathen Chinee is peculiar."

The alternative of simply forcing through a rate without chance of discussion by the workman is a plan that never works for very long unless the rate determination is based on thoroughly uniform and just methods; it will not answer to have different prices given out for the same or similar work at different times, for, aside from the inherent injustice involved, it is wonderful how well the men keep posted. Mere estimates, as usually arrived at by reliance on the experience of the rate fixer, never can, even with the most just and capable of estimaters, attain the necessary consistency. Let a machine have come out too high in total costs and the rate fixer will inevitably reflect this experience in setting low rates for some time until the impression has worn off; similarly, if a machine has come well within the estimates, the involuntary tendency is toward greater liberality.


Roughing cuts are $\frac{3}{16}''$ deep if stock permits; deeper if job is stiff; get to within $\frac{1}{16}''$ of finish size in fewest possible cuts.

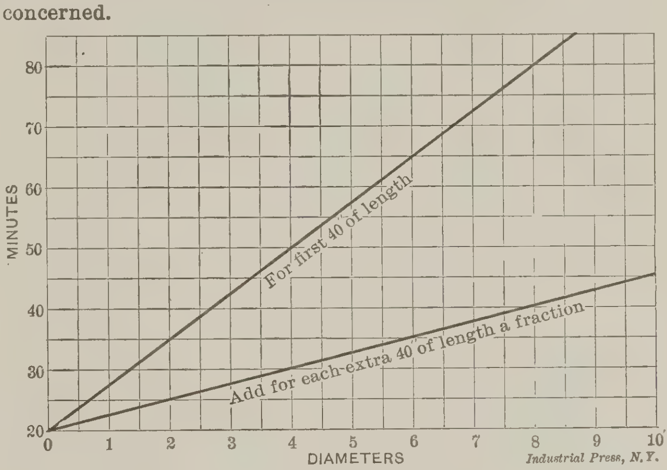
Finishing cuts: For ordinary truth, "b" remove $\frac{1}{16}''$ stock in one cut; for special truth, "a" take two cuts.

For Grinding: Use roughing cuts only, but get down to within $\frac{1}{32}''$ of finish size.

Industrial Press, N. Y.

Fig. 1. Chart giving Estimates for Turning Plain and Shouldered Shafts, etc.

But substitute for such guesswork definite rules based on observation and experience and rigidly adhere to them and it will not be long ere the men recognize the consistency of the prices set, and evince a willingness to abide by the rate fixer's dicta and second him in his efforts to the advantage of all concerned.



Industrial Press, N. Y.

Fig. 2. Handling Allowances.

The rate-fixing methods worked out by Mr. Taylor and his school (I suppose it is as legitimate to speak of a school in matters of the shop and industrial arts as it is in the domain of the fine arts and letters) aim at this by a most minute study of all the elements affecting a given piece of work. Nothing better than these methods has as yet been proposed, but there are so far very few men trained to carry out and apply them; employers willing to incur the necessary first cost and time are also few and far between. Meanwhile half a loaf is better than none, and methods that have been found of decided utility and adaptable to the practice of various shops will answer very well so long as the more thorough ones are out of reach. In the main these consist in plotting on charts the results of experience with the individual operations into which any piece of work may be readily divided and in then using these charts to fix the time for new work. The estimates being thus always made on the same fixed basis are necessarily consistent. Continued comparison of actual results with the predictions of the chart will very soon, even with originally defective charts, lead to their correction, a work to which co-operation of the better and more intelligent and progressive element among the workmen will soon be cordially given.

Fig. 1 is such a chart for the turning of plain and shouldered shafts and spindles. As will be noted the base line gives one series of dimensions, in this case shaft diameters; various lines and curves in the body of the chart refer to some other main dimension, lengths in this case; and the vertical scale gives the time in minutes. The lines have been plotted as the result of observations which showed that up to about four inches diameter the time increase was less than directly proportional to the diameter, while after that for any given length the time increase could be represented by a straight line. Observation further showed that relatively more time is taken for long than for the shorter lengths. This is the reason that on the chart the time intervals between the curves for the various lengths are least in the region of the shorter shafts; the underlying cause is that long work is more springy than short, and therefore cannot be as quickly reduced.

The curves give the time for turning only, and, as there are time losses involved in handling, tool setting, etc., these also must be considered. Such losses are practically proportional to the diameter and are given in Fig. 2 as "Handling Allowances." For all lengths up to 40 inches no change is made for length, but for each extra 40 inches an amount is added that is given by the lower of the two curves on the chart.

There remains the time for the work of turning up the ends and the shoulders. This allowance is taken from Fig. 3, marked "Time for Ending and Shouldering." Within the limits of the chart, 10 inches diameter, the time increases faster than the diameter. The time for each end is given by the upper curve, while that for each shoulder is given by the lower curve.

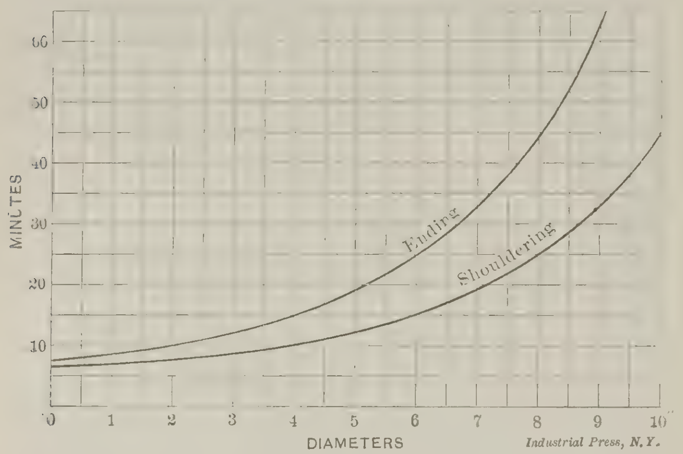


Fig. 3. Time for Ending and Shouldering.

As an example take the shaft shown in Fig. 4: Assume that this is to be turned out of solid stock 3⅞ inches diameter. Roughing cuts of 3-16 inch depth per side may be taken as a least depth. The first roughing cut would reduce the length marked I from 3⅞ to 3 9-16 inches, leaving the 3½ inches section ready for the finishing cut. Referring to Fig. 1, 30 minutes is given as the turning time for a length of 16 inches at 3⅞ inches diameter. A second, rather heavier roughing cut over II will reduce the sizes from 3 9-16 inches to 3 1-16 inches in 14 minutes by the chart. The last roughing cut will reduce 3⅞ inches to 3 3-16 inches; this is a cut of ⅜ inch depth per side, but as the length is only 18 inches, and moreover at the shaft end, this depth of cut is permissible. The time as taken from the chart is 34 minutes. If the work is to be quite true two finishing cuts should be employed for bringing it to size. For many purposes one cut will suffice; "a" marked on the size calls for two finish cuts, while "b" stands for one. By the chart the finish cut II for 6 inches length at 3 inches diameter takes 13 minutes, and two cuts, therefore, 26 minutes; the 10 inches length at 3½ inches diameter takes for two cuts 2 × 20 = 40 minutes; the one cut indicated by "b" at 3¾ inches diameter requires 74 minutes for its length of 40 inches; the 3⅛ inches and 18 inches long section uses up 2 × 32 = 64 minutes. The handling allowance by the chart, Fig. 2, is 59 minutes for the first 40 inches of length and 30 minutes for the next 40 inches or less; that gives a total of 79 minutes. Chart Fig. 3 for ending gives for each 3 inch end 12 minutes, or 24 for the two ends. The two shoulders at 3¾ inches diameter each take up 10 minutes, and the remaining shoulder at 3½ inches diameter 9 minutes, a total for shouldering of 29 minutes. Grouping the figures found for a more convenient oversight and addition we have:

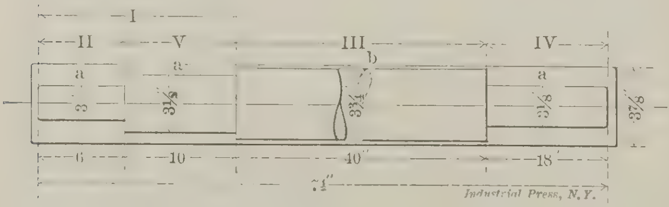


Fig. 4. Shaft to be Turned out of Solid Stock.

	Minutes.
I—One roughing cut 3⅞ inches to 3 9-16 inches x 16 inches length	30
II—One roughing cut 3 9-16 inches to 3 1-16 inches x 6 inches length	14
IV—One roughing cut 3⅞ inches to 3 3-16 inches x 18 inches length	34
II—Two finishing cuts 3 1-16 inches to 3 inches x 6 inches length	26
V—Two finishing cuts 3 9-16 inches to 3½ inches x 10 inches length	40
III—One finishing cut 3 13-16 to 3¾ inches x 40 inches length	74
IV—Two finishing cuts 3 3-16 inches to 3⅛ inches x 18 inches length	64
Handling allowance	79
Ending allowance, two 3-inch ends	24
Shouldering allowance, two at 3¾, one 3½	29
Total	414
	Say 7 hours.

The times derived from the charts are readily made by average men with lathes of ordinary stiffness and power and the common tool steels, which insures a liberal margin for high earnings by the piece or premium plan.

These charts are not presented as being correct for every job and every shop; no chart could be even approximately that. The time in which a certain piece of work can be done depends upon the lathe and the condition of its driving belt, upon the man at the lathe and his environment; in fact, upon very many conditions, some of which, from their very nature cannot possibly be correctly allowed for. The only way of getting really and closely down to the lowest attainable time is by a most minute study of every controllable condition for each machine, and then seeing to it that the machine is in every way always maintained in prime order. As already stated, that involves an amount of work and also a method of shop foremanship that few are ready to accept, though such methods are undoubtedly capable of returning far more than their cost in increased output. None the less, these charts, or modifications based on experience in a particular shop, can be made to do very good service. With their aid a single man can set the rates for a surprisingly large number of jobs in a short time. My experience has proven that one man, aided by good detail plans, is able to set the entire times for all of the machining work on a machine tool weighing net about 30,000 pounds. As stated at the outset, one

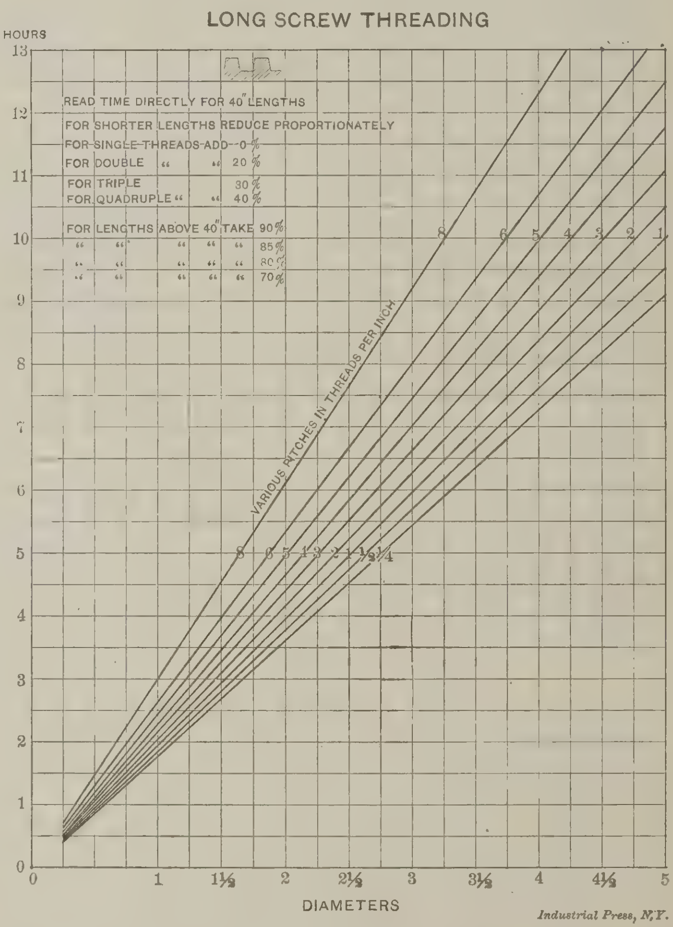
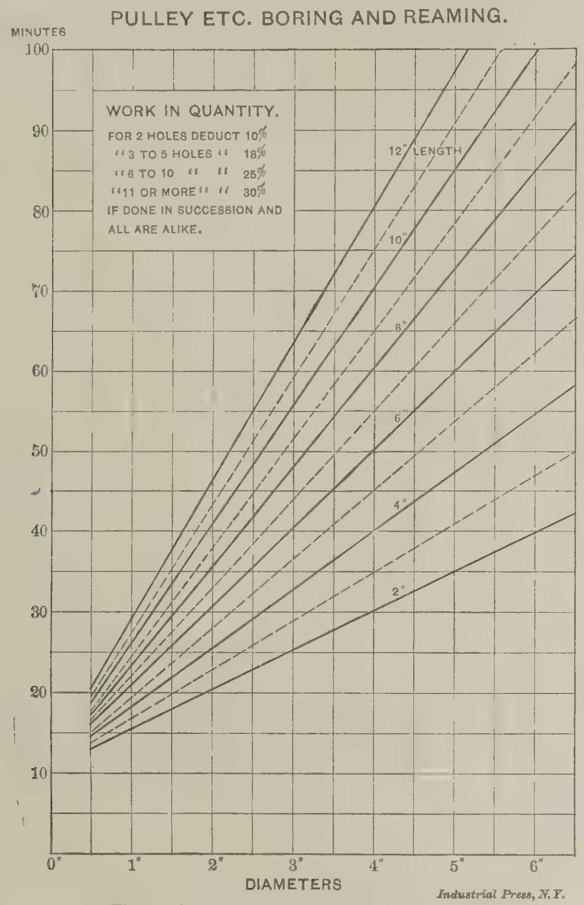


Fig. 5. Time Estimate for Screw Threading.

advantage is that the times are set consistently, obviating the giving out to the shop of times that vary widely for practically identical jobs, as is inevitable even with the most careful and experienced men relying only on their judgment and memory of precedent. With the charts relatively inexperienced and cheaper men can do the work and make material errors only by gross carelessness. Should it be considered desirable, the work of one man can also be checked by a second one whereas under the older methods such checking is practically out of the question.



Industrial Press, N.Y.

Fig. 6. For Boring and Reaming a Pulley.

The charts, Figs. 1, 2 and 3, are for ordinary lathe work; Figs. 5, 6 and 7 give time estimate for threading long screws, for pulley boring and turning, etc.

Estimating Time for Long Threading.

Fig. 5 extends this subject to the threading of long screws, such as leadscrews, feedscrews, etc. It applies to the usual section having the sides inclined to include an angle of thirty degrees; but variations in this angle do not materially affect the time. Actually square threads will require more time if there is to be a genuine side fit; as this form has gone practically out of use, for close work at least, it may be disregarded. The character of the work on which the time is based is such as is usually found in the standard grade of machine tools. A good lathe hand should be able to earn a fair bonus over and above day rates by shortening the time taken from the chart, Fig. 5.

For single threads the time is to be read directly from the chart; for double threads 20 per cent. is to be added to compensate for the extra handling and the increased number of cuts; for triple threads 30 per cent. is added, and 40 per cent. for quadruple threads fairly represents the extra time taken up; 40 inches is assumed as the shortest length to be cut. Time needed does not increase proportionally, or at least not directly so; this will be fairly recognized by taking for the increased lengths 90, 85, 80 and 70 per cent. of the times derived from the chart for the first 40 inches for single, double, triple and quadruple threads respectively.

Logically, lengths of less than 40 inches should be assigned time at an increased ratio; but as screws of the character being considered are rarely much shorter than 40 inches it is advisable to avoid complications by reducing the chart times in direct proportion.

By the chart a leadscrew of 3½ inches diameter, single, two threads per inch and 140 inches long, should be threaded in 7.3 hours for the first 40 inches and in $0.9 \left(\frac{140 - 40}{40}\right) 7.3 = 16.4$ hours for the rest of its length, or a total of 23.7 hours for the entire length.

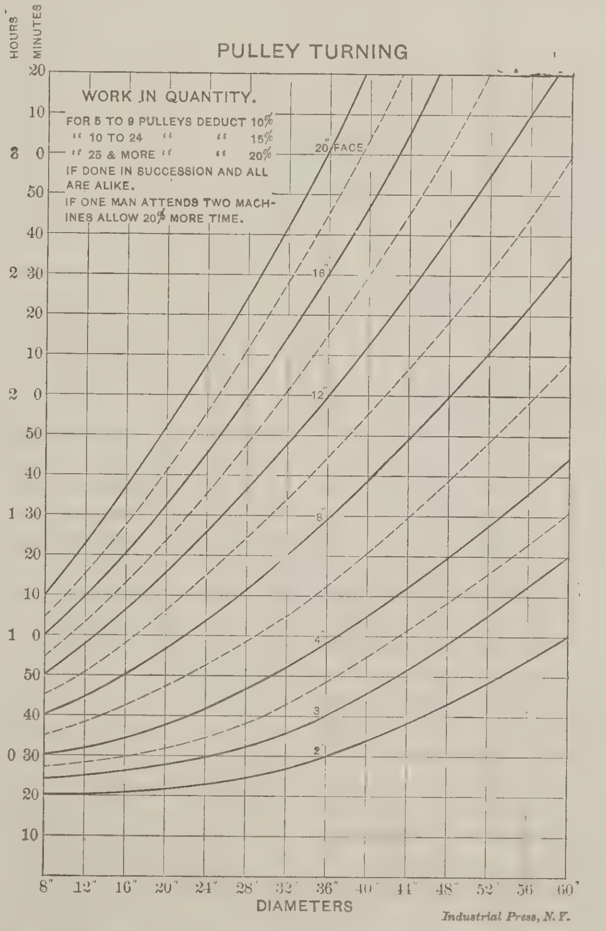
Were the thread to be double, the times would be 7.3 + 20 per cent. = 8.75 hours for the first 40 ins. and $0.85 \left(\frac{140 - 40}{40}\right) 8.75 = 18.5$ hours for the balance, or 27.5 hours for the entire length.

The time given is that for the threading only; the turning time for preparing the screw for threading is found from charts Figs. 1 to 3 for plain turning.

Time for Pulley Boring and Reaming, Turning and Polishing.

The time required to bore, ream, turn and polish pulleys will vary greatly with the facilities provided. Good results with trained shop laborers can be had if the boring and reaming is done on vertical turret boring machines, finishing the hole with a hand reamer while holding the pulley in a reaming stand fitted with a universal chuck. Turning and polishing is done in pulley lathes of the type having a rest back and front and a fast running polishing arbor that can be used while the turning is going on.

For boring and reaming, the time varies with the diameter and length of the hole, and, of course, also with the number of one size being dealt with successively. Fig. 6 gives the time in minutes for bore diameters up to 6 inches and 2 to 12 inches length of hub. To bore and ream a single hole 4 inches diameter by 6 inches long will, according to the chart, Fig. 6, take 50 minutes time. If from six to ten similar pieces were to be treated successively the time would be reduced by 25 per cent. to 37 minutes; the small table in the corner of the chart gives the reduction for lots of various quantities.



Industrial Press, N.Y.

Fig. 7. For Turning and Polishing Pulleys.

The chart is based on the use of one rough boring cut, followed by a rose reamer, and that in turn by a machine reamer; as mentioned before, the final sizing is by hand reaming. The time is susceptible of considerable shortening by active men and by attention in the foundry to careful centering of the core and a minimum amount of finish. The chart is, of course, useful also in connection with boring and reaming on other work than pulleys, so long as the material is cast iron and the shape does not interfere with as ready chucking.

To determine the time for turning and polishing pulleys chart Fig. 7 is used. This shows that a pulley 36 inches diameter by 8 inches face would require 1 hour and 30 minutes; doubling the face to 16 inches would add another hour, as found by reference to the curve marked 16 inches face as against that marked 8 inches face.

Pulleys are frequently made up in larger lots with a consequent economy of time; the saving is given by the small table printed on the chart; by that, if 10 to 24 of the above mentioned 36-inch by 8-inch pulleys were to be dealt with in one lot, a saving of 15 per cent. of the 1½ hours = 13 minutes per piece would be had. It is quite usual to have one man attend to two pulley lathes; that always means a reduction in the output of each machine, fairly represented in this case by an increase of 20 per cent. in the time allowance given by the chart.

Many more charts for various operations might be given from the writer's practice, but they are all for more specialized work; on such work the results in different shops vary so widely, in accordance with the machines and fixtures provided, as to rob the charts of nearly all value to others, unless they were accompanied with a description of appliances so in detail as to be hardly practicable for these pages, from considerations of available space.

On comparing the charts given with results in the shop a difference is certain to be found; similar charts based on local experience may then be made out, or the results given on the charts may be modified in the observed ratio. This is very easily done by the laying down of a new time scale; the latter course is preferable for a time, or until a sufficient number of comparisons have been accumulated to serve as a fair basis for new charts.

The writer hopes that others may be induced to give in any form most convenient to them the times for standard operations, to the end that gradually a fund of information may be accumulated that will greatly aid in the economical turning out of work, while helping to remove some of the barriers to a mutual understanding between the workers and those who now only too frequently consider themselves the "worked."

* * *

VARIABLE SPEED MOTORS.—2.

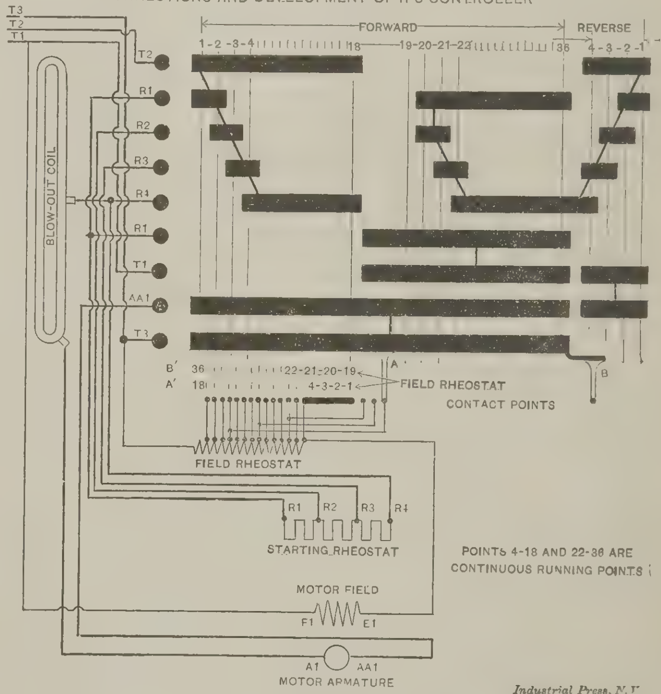
WILLIAM BAXTER, JR.

A diagram of the multivoltage controller of the General Electric Company is shown in Fig. 5. In this system the voltages are in the ratio of two to one, so that when the higher voltage is used the motor velocity is doubled. Other speeds are obtained by means of field regulation, and as the motors are proportioned so as to give a variation of two to one, any velocity between those due to the two voltages can be obtained by connecting the motor with the lower voltage and introducing the proper resistance in the field circuit. The normal velocity obtained with the motor connected with the high voltage can be doubled by introducing all the regulating resistance in field circuit. From this it will be seen that a range of velocities of four to one is obtained.

The field regulating rheostat is divided into fourteen sections, and as these can be cut in or out with either of the two voltages, twenty-eight different speeds are obtained. The controller cylinder is provided with additional contacts for reversing, the speed in the reverse connection being that due to the low voltage.

In the forward motion, when the controller is moved to the first step, the middle line wire $T2$ connects with the top cylinder ring, and the line $T3$ connects with the bottom cylinder ring. The stationary contact $R1$ rests on the second cylinder contact on the first step and contact $AA1$ rests on the eighth cylinder ring on all the steps. From this it will be seen that the circuit from $T2$ will be through $R1$ to and through the starting rheostat to $R4$, thence through the blowout coil to the motor armature, through the latter to controller contact $AA1$ and through the two lower cylinder rings to contact $T3$, and thus to line wire $T3$. This connection places the motor armature in circuit with the low voltage lines. The motor field coil circuit starts from the $T3$ contact of the controller and ends at the $T1$ line wire, thus connecting the field across the high voltage mains. When the controller is in the off position, the arms A and B are in the position shown, but when the controller is moved to the first step, A advances to the position 1 on the field rheostat contacts, and, as will be seen, rests on the long contact that is connected with one end of the rheostat and also with the field coil; therefore, the current from $T3$ passes directly to the motor field coil without traversing any of the field rheostat. In moving through the next four steps the controller simply cuts out the starting resistance, but in the following steps, up to the 18th, successive sections of the field rheostat are cut into the field circuit. When this last named step is reached, A is in the position 18 to the left of the field rheostat contacts, and B is but a short distance to the right of the position in which A is drawn. The movement of the controller in passing from 18 to 19 is quite long, and during this movement arm B passes over the three contacts at the right of the field rheostat, and by doing so cuts out of the field circuit in four sections all the field rheostat, so that when the 19th step is reached there is no external resistance in the field. The cylinder rings of the controller, in passing from the 18th to the 19th steps disconnect $T2$ and $R4$ and connect $T1$, $R1$ and $R2$ thus connecting the motor with the high voltage lines and at the same time cutting in two sections of the starting rheostat. In the next three steps the starting rheostat sections are cut out, and then arm B begins to move across the field rheostat contacts and cuts this resistance into the field circuit section by section, the last section being cut in when the 36th step is reached.

CONNECTIONS AND DEVELOPMENT OF H-6 CONTROLLER



Industrial Press, N.Y.

Fig. 5

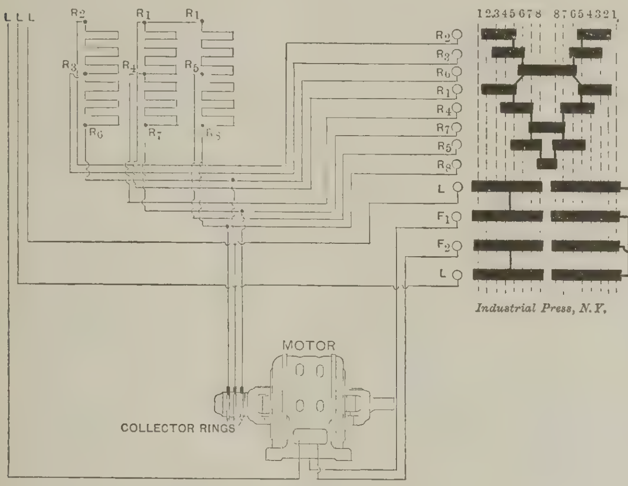
Variable Speed Alternating Current Motors.

The induction motor is the only alternating current machine that is suited, at the present time, for variable speed work. The speed of an induction motor can be varied by introducing resistance in the rotor, or secondary circuit, which amounts to the same thing as introducing resistance in the armature circuit of a continuous current motor. This method, which is called rheostatic control, the same as when applied to continuous current motors, is used by the General Electric Company.

The speed of induction motors can also be varied by providing two or more sources of current, each one having a different frequency. This method of control is the equivalent, in effect, of the multivoltage systems used with continuous currents, as the speed variations are proportional to the frequency changes in the same manner as with continuous currents the speed changes are proportional to voltage changes.

With the continuous current system, if only one voltage is available, additional voltages are provided by the use of one or more motor generators, which are commonly called balancers. In an alternating current system, if currents of one frequency only are available, other currents of other frequencies can be provided by the use of one or more motor generators.

While by the use of two or more frequencies different speeds can be obtained, the system has not come into use except perhaps in a few isolated cases; it is not a standard system, and controllers to operate with it are not regularly made.



Industrial Press, N.Y.

Fig. 6.

Another way of changing the speed of induction motors is by changing the number of poles of the motor; thus if the motor field, or primary winding, is arranged to develop say sixteen poles, and run at five hundred revolutions with this number of poles, it can be made to run at one thousand revolutions by changing the number of poles to eight. This method of changing or doubling the speed of induction motors is used by the General Electric Company. The pole changing method of control combined with the rheostat method, will give as wide a range of variation as may be desired, it being from the highest velocity, which is obtained with the field connected for the small number of poles down to the minimum, which is obtained with the field connected to give the larger number of poles, and all the rheostat cut into the secondary circuit.

The diagram, Fig. 6, shows the arrangement of the rheostat controller for induction motors. This controller, as will be seen from the development of the cylinder rings at the right side of the diagram is of the reversing type, and will give the same number of speeds with the motor running in either direction. If the rheostats are made of sufficient capacity, throughout, to carry the working currents continuously, the controller can be left in any position, and thus eight different speeds can be obtained. Generally, however, the first few steps are used simply for the purpose of starting, and only three or four of the last positions are running steps.

Fig. 7 is a wiring diagram of a pole changing controller of the reversing type. This controller as will be noticed moves through two steps only, the first one connects the line wires with the motor wires 1, 2, 3, and the second step connects the line wires with motor wires 4, 5 6. When the controller is moved to the first step the motor is connected so as to have the larger number of poles, and run at the lower velocity. When the controller is moved to the second step the motor poles are reduced to one-half the number, and the velocity is doubled.

* * *

TWO QUERIES.

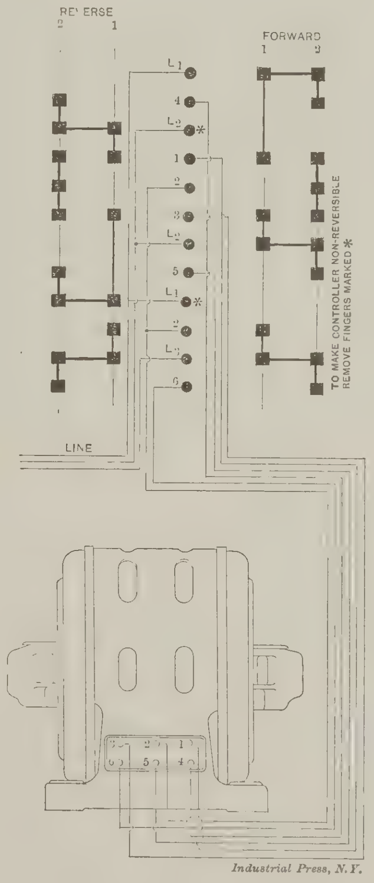
A subscriber wants information on the proper proportions of bells. Another wants similar data regarding steam whistles. Contributions on either or both these subjects will be acceptable and doubtless will be appreciated by many, as there seems to be nothing published on either subject that is generally available.—Editor.

THE LATENT HEAT QUESTION.

IS STEAM THE BEST VAPOR FOR POWER PURPOSES?

In the effort to improve the steam engine the proposition is often advanced to substitute the vapor of the more volatile liquids, like chloroform, ether, alcohol or carbon bi-sulphide for the vapor of water. A short time ago we were approached by the inventor of an ether motor who was looking for information, which suggests the topic at this time.

Although there have been many motors of this character devised and actually constructed—most of which have, for one reason or another, proved failures—the fact that these volatile liquids are so easily vaporized and attain such high pressures without absorbing an enormous quantity of heat—such as is represented by the latent heat of steam—makes them appear attractive. Their quality of vaporizing at low temperatures has led to the development of the binary vapor engine, which has met with some degree of success. The binary vapor engine has two cylinders, similar to a compound engine. One cylinder is for steam and the other for the vapor from some volatile liquid, usually ether. The exhaust steam from the first cylinder passes into a form of receiver which acts as a condenser for the steam and as a boiler for the volatile liquid, the liquid being on one side of the tubes and the steam on the other side. The volatile liquid acts like condensing water in condensing the steam, and the heat from the steam is sufficient to vaporize the fluid for use in the vapor cylinder.



Industrial Press, N.Y.

Fig. 7.

It would appear that if vapors from volatile liquids are to be of much value for power purposes, it would be in some such way as the foregoing. The very fact that they vaporize at low temperatures means that when used in a single cylinder engine, the back pressure at exhaust would still be so high as to impair the economy of the engine, unless a large amount of condensing water is provided at very low temperature.

Characteristics of Steam and Chloroform.

In instituting comparisons between steam and the vapors of volatile liquids it will be easier to use French units instead of English units, because most of the tables of the properties of these vapors are published only in the French system. Taking for illustration, steam at 160 degrees C. (equivalent to about 90 pounds pressure), assuming it to expand in an engine cylinder down to 40 degrees C. (or about 1 pound absolute pressure) and comparing it with chloroform under similar conditions, we find that the latent heat of the steam at the higher and lower temperatures respectively is 494 and 579 calories, while the latent heat of chloroform is only 51 and 63 calories, or only about one-tenth that of the steam. On the other hand, the pressure of the chloroform at the higher temperature is about 169 pounds, or nearly double that of the steam. When it is considered that it is pressure which makes the piston move, and that so large a proportion of the latent heat of steam passes out through the exhaust pipe of an engine, it is no wonder that these volatile vapors have proven attractive. A few calculations, however, will show that steam is, after all, the most satisfactory substance to use, especially when it is considered that it comes from water—a universal substance which is non-inflammable and does not involve a one-quarter part of the danger in its use that must be experienced with the other substances. Stated briefly, steam will produce the best results per unit weight; but a vapor like chloroform which has so high a pressure for a given temperature, and consequently occupies so small a space in proportion to its weight, will produce the greater power per unit volume. That is, while a greater weight of chloroform, for example, would theoretically be used to produce a given power, an engine using chloroform would produce more power than a steam engine with the same size cylinder.

Chloroform is Better, Theoretically, but not Practically.

In Peabody's Thermodynamics, to which the reader is referred, calculations upon the available power per unit weight and unit volume of steam and chloroform are carried out as outlined below. The attempt will not be made here to give either the theoretical basis for the calculations, or even the steps in the process, as a brief statement of the results will answer our present purpose.

The theoretical consumption of an engine may be roughly calculated by multiplying the latent heat of the vapor at the temperature at which it is used by the efficiency of the engine, calculated by the well-known method of dividing the difference of absolute pressure by the absolute higher pressure. For steam at 160 degrees C. expanding to 40 degrees C., we find the efficiency to be .28, and the heat converted into work, 137 calories. For chloroform working between the same temperatures the efficiency is, of course, the same, being independent of the working substance, but the calories converted into work are only about 14, or nearly ten times as much in one case as in the other.

But if we are to consider volumes instead of weights calculation shows that for an engine having a cylinder containing one cubic meter in volume only 8.7 calories would be converted into mechanical work per stroke when steam is used, as against 34 for the chloroform. This is because of the very small volume occupied by chloroform vapor per unit weight.

To make the comparison fairer, however, suppose the steam to be used at the same *pressure* at which the chloroform is used instead of at the same *temperature*. Then we find 151 calories converted into work per kilogram, and about 10 calories per stroke of the engine. These figures show that in spite of their disadvantages the vapors of volatile liquids have some advantages from a purely theoretical standpoint. It seems a reasonable conclusion, however, that the theoretical advantages of the volatile liquids are many times over-balanced by their practical disadvantages, such as cost, inconvenience, danger, high exhaust pressure, and unstability; the latter due to low latent heat, which means low reserve power.

Latent Heat is not a Disadvantage.

Probably this question of the latent heat is what has led so many to investigate the value of the vapors of volatile liquids for power purposes. The large amount of latent heat that passes off in the exhaust in a steam engine has been looked upon as lost and it has been reasoned that a vapor having less latent heat to lose would be more efficient. Some years ago, however, the question of substitutes for steam was quite thoroughly presented by Mr. George H. Babcock, in a paper before the American Society of Mechanical Engineers. He showed by simple calculation that latent heat is not necessarily wasted heat; or, in other words, that if all the heat received in evaporating water were expended in elevating the temperature, instead of a large share of it going into the latent condition, we should not be able to turn into work nearly as large a proportion of the heat supplied to the steam as under actual conditions. Assuming that steam be supplied at 220 degrees temperature—75 pounds gage pressure—and that it exhausts at about 100 degrees temperature—or 28 inches vacuum—the efficiency when working on a perfect cycle would be .28 and the heat expanded per pound of steam would be 220 (heat in the water) × .475 (specific heat) × 772 = 80,674 foot pounds; 28 per cent. of this is 22,588, which is equivalent to 87.6 pounds of steam per horse power hour—rather an extravagant expenditure for a perfect engine!

A crude but rather effective analogy to the latent heat of steam is the weight of the water for driving a water motor. The height of the source of supply may be said to correspond to the temperature of steam; the weight, to the latent heat, and the pressure which compels the motor to rotate corresponds to the pressure of steam. It is evident that this pressure is dependent both on the height of the source of supply and the weight of the water, and in a similar manner the pressure of steam is dependent both upon the temperature and the latent heat of the steam.

It is by means of the latent heat that the pressure can be sustained after the point of cut-off, to the extent to which it is throughout the stroke of the piston; and it is because of this latent heat that so large a proportion—small though it is—of the heat units put into the steam by the furnace fire can be taken out again in the form of mechanical work. While the greater part of the latent heat is, of course, given up by the exhaust, it is not conceivable that the excellent and economical results produced by the steam could be obtained in any other way.

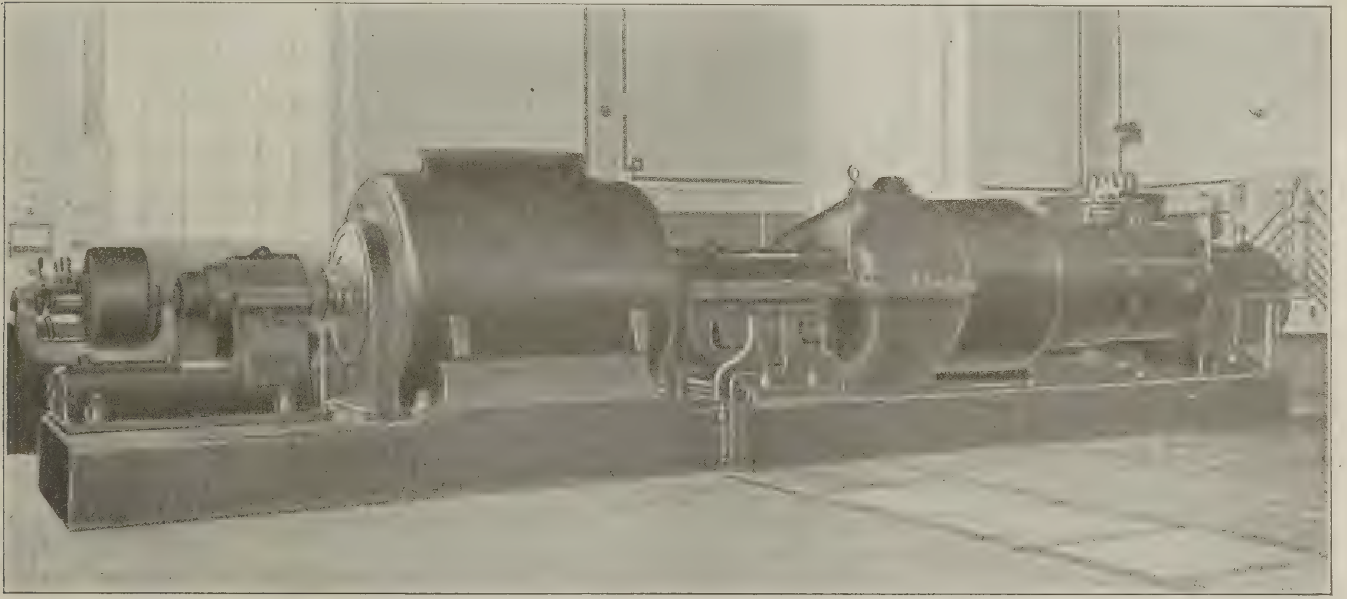
Better than theoretical considerations, however, are actual tests; and in the discussion that follows Mr. Babcock's paper, which was presented eighteen years ago, Prof. Trowbridge, of Columbia University, quoted results from a test upon a bisulphide of carbon apparatus. From results of the tests the efficiency was found to be .167; and from results of a test of a condensing steam engine under similar conditions the efficiency, strangely enough, figured out to .157, or practically the same—a remarkable coincidence, when it is considered that each of the results depended upon experimental data. The comparison verifies the law that the efficiency of an engine is independent of the working fluid, although, of course, this does not take into account the action of the cylinder walls in producing condensation and re-evaporation in the cylinder.

* * *

A short time ago the work of demolition of the great Burden water wheel at Troy, N. Y., was commenced, but the action aroused such a great amount of opposition that the work was stopped, and an effort is being made to have the wheel restored and allowed to stand to the memory of Henry Burden, who was its designer and builder, and whose iron mill it operated for many years. The wheel is said to be the largest construction of the kind ever erected and therefore it has a double interest. The wheel is 60 feet in diameter and 20 feet wide. It has 36 huge buckets. The journals of the great wheel are 16½ inches in diameter and 18 inches long and it has 264 spokes, each 1½ inches in diameter. The wheel was first put into operation in 1849 and ran almost continuously until 1895, when the works were abandoned. Making two and a half turns per minute, this wheel ran the entire plant, which consisted of one rotary squeezer and muckbar train, five 9-inch trains for rolling horseshoe, and rivet iron, five or six rivet or spike machines, about thirty punching machines, machine shop roll lathes, shears, and other machinery called for about a rolling mill. At this plant Henry Burden invented and improved a number of processes. The most important and the one for which he is chiefly known is the horseshoe making machine, which, was one of the greatest inventions of the time. Burden also invented the rotary squeezer, which is in use in all mills where iron is made by the puddling process.—*Scientific American.*

TESTS ON A 4,000 H. P. STEAM TURBINE.

In connection with the Dresden Exhibition of German Civic Life, the municipal electricity works of Frankfort-on-the-Main published some tests made on a 4,000 horse power steam turbine (system Brown-Boveri-Parsons, Switzerland) which had been installed in one of their central stations. The turbo-dynamo is designed to operate under a steam pressure of 13 atmospheres, using superheated steam at 300 deg. C. and giving outputs as high as 2,600 kilowatts at a pressure of 3,000 volts, 1,360 revolutions per minute. It is 16.5 meters in length, 2.5 meters in breadth and 2.5 meters in height. All the parts of the steam turbines are easily accessible, the whole of the interior becoming visible through unscrewing the upper cylinder cover. The engine is of very easy and simple operation and superintendence, only 15 minutes being necessary to preheat the turbine cylinder from the cold state. The regulation of the turbine is extremely accurate, the steam requiring to traverse the turbine only a fraction of a second, which makes the effect of controlling on the only inlet valve felt instantaneously. Though the steam enters by puffs, the uniformity in the working of the turbine is remarkable. The turbo-alternator works readily in parallel with other alternators, operated by reciprocating engines, the more so as the rotating magnet field is analogous to the rotors of asynchronous motors. The following table records some experiments in the course of normal operation, the figures stated being average values:



Brown-Boveri-Parsons Turbine.

Steam Pressure before Inlet Valve. (Atmospheres)	Temperature of Superheated Steam. (Centigrade.)	Load in K.W.	Vacuum per cent. of Barometer Reading.	Steam Consumption kg/K.W. Hour.
12.63	298	1945	93.2	7.20
12.8	295	2518	91.8	7.09
10.6	312	2995	90.0	6.70

According to the contract, the steam consumption was to be not higher than 7.2 kg. for a superpressure as high as 12.8 atmospheres, a superheat of 300 deg. C. and a load of 2600 KW. From the above table it is inferred that the actual steam consumption is much below these figures, showing the steam turbine to work at least as economically as the most perfect reciprocating engines of the same size. A. G.

[The foregoing illustration of a leading type of steam turbine, as made by the famous firm of Swiss engineers, and the results of authentic tests upon a large turbine of this make, are of general interest. The data, however, will be more intelligible if given in English units, and we have therefore converted the figures to this form in the table below:

Steam Pressure, lbs. sq. inch.	Temp. of Steam, Fahr.	Degrees of Superheat, Fahr.	Load in KW.	Vacuum, Inches of Mercury.	Steam Consumption, lbs. per K.W. Hour.
185.7	568.4	193	1945	28	15.8
188.2	563	186.4	2518	27.5	15.6
155.8	593.6	232.4	2995	27	14.7

Taking the best result—14.7 pounds per KW hour—and comparing it with the best results from reciprocating engines, will show that the turbine in its present state of development is just about equal in efficiency to the reciprocating engine. The efficiency of the turbine, however, is nearly uniform under a varying load, while the efficiency of the reciprocating engine varies greatly with the load; or in other words, the average efficiency of the reciprocating engine is very much lower than of the turbine. One of the greatest losses in the turbine is due to the leakage of steam through the passages between the wheel blades and guide vanes, and if this should be remedied we may look for a further improvement in turbine efficiency.

Referring to the last test quoted above, let us assume that the generator of this turbine had an efficiency of 95 per cent. The consumption of 14.7 pounds of steam per kilowatt-hour is derived from the measured output of the generator and hence what would be the equivalent brake horse power of a steam engine under similar conditions would be determined by dividing 14.7 first by 1.05 and then by 1.34, the number of horse-power hours equal to one kilowatt-hour. This gives us 10.48 pounds of steam per horse-power hour, certainly a remarkably fine performance when measured in brake horse power. Now assuming the frictional loss in a steam engine to be 10 per cent. of the total power developed, the consumption of an engine which used 10.48 pounds of steam per brake horse power per hour would be 10.48 ÷ 1.10 = 9.5 pounds per indicated horse power per hour. This is rather better than the best results from reciprocating engines using superheated steam; but tests thus far have been from comparatively small engines, while the turbine figures are from a 4,000 horse power unit. With a reciprocating engine of corresponding size, using superheated steam, we should expect the consumption at normal load to be as low as that of the turbine, but as previously stated, its average rate would be much higher.—EDITOR.]

* * *

It is well known that the automobile is, to a large degree, a helpless machine in freshly fallen snow and that it climbs hills with great difficulty even when the snow is well packed. It appears that the slipping of the wheels is largely caused by the tires becoming heated by internal friction so that the snow is melted next the tires, which, of course, puts them in the very best condition to slip. The usual plan followed when driving the automobile in snow is to wind the tires with rope, which serves the double purpose of presenting a corrugated surface and of not transmitting the heat directly to the snow. Internal tire friction is a serious factor in the operation of high-speed machines, the tires frequently becoming so hot as to be ruined, either by disintegration of the fabric, or in the case of pneumatic tires, by bursting because of the expansion of the air.

NOTABLE INSTALLATION OF THE RENOLD SILENT CHAIN.

What is said to be the largest single installation of chain drive ever made, was recently put in the Arlington Mills, Lawrence, Mass., by the Link-Belt Engineering Co., Philadelphia, Pa., the total equipment aggregating 1,056 horse power, and all being the Renold silent chain, which the company controls in this country.

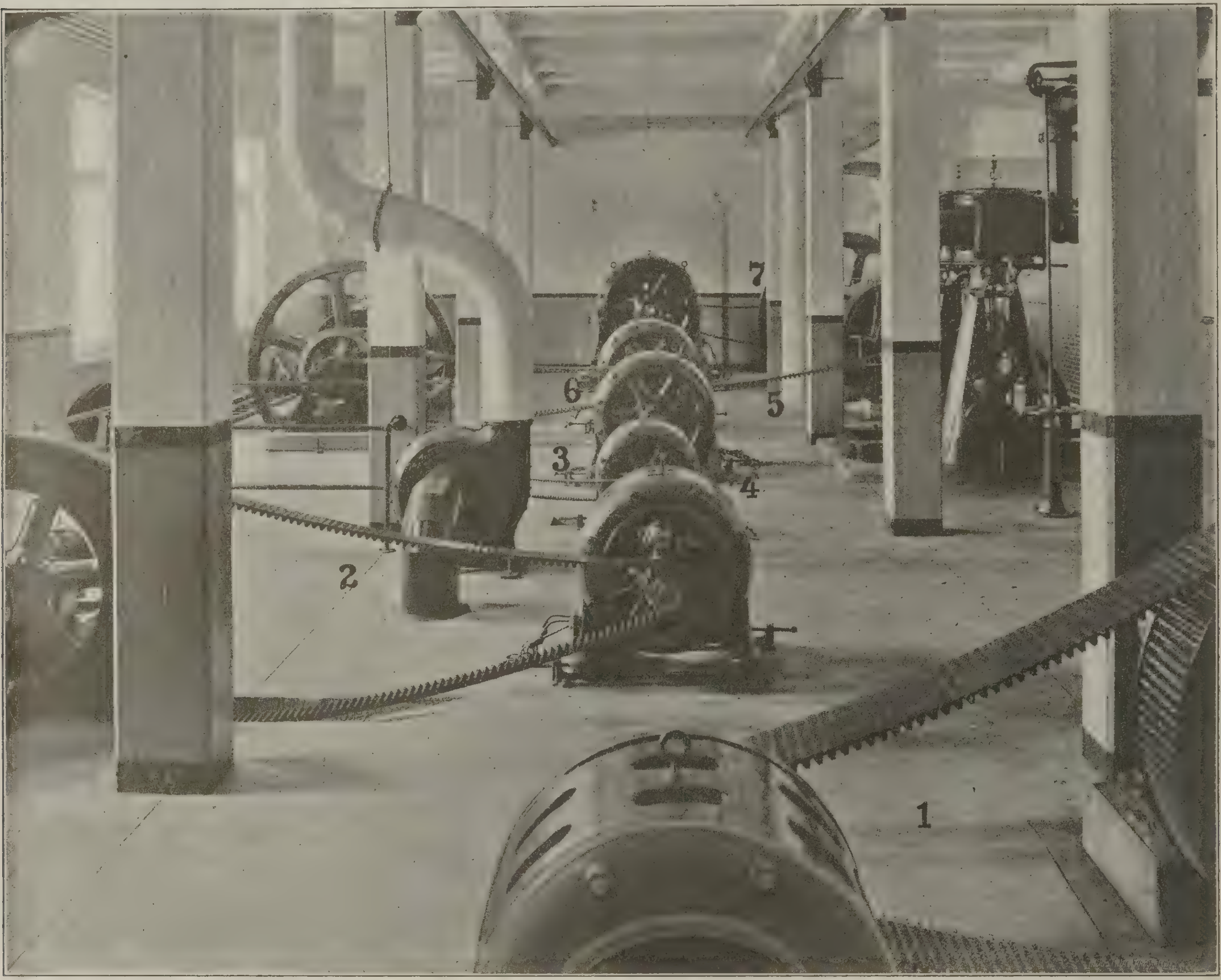


Fig. 1. Over 1000 Horse-power Transmitted with Renold Chains in one Installation.

Fig. 1 shows a general view of the installation, there being seven machines in all that are equipped with chain drive. They comprise a 100 horse power gas compressor (1); 60 horse power air compressor (2); 6 horse power exhaust fan (3); 30 horse power centrifugal pump (4); 100 horse power exhauster (5); 260 horse power auxiliary blower (6); and 500 horse power gas compressor (7). It is estimated that there is a clear saving of 25 per cent. of power made by the use of the chain drive; moreover, there is no danger from fire by sparking as would be the case with leather belts in this instance, since there is a large quantity of naphtha handled in this room.

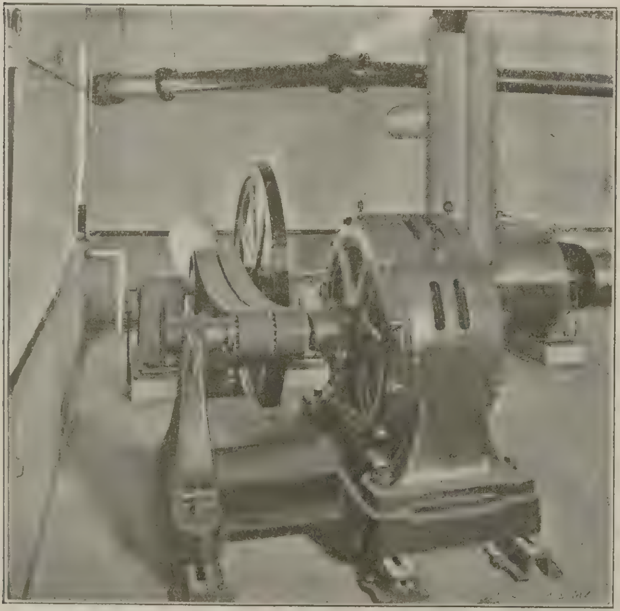


Fig. 2. Five Hundred H P. Gas Compressor Driven by Chain

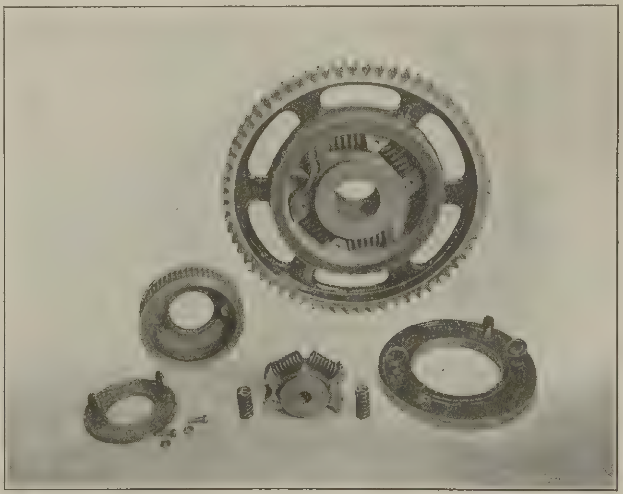


Fig. 3. Spring Compensating Centers for Gears.

Fig. 2 shows the 500 horse power gas compressor drive individually and close at hand. This is the latest development in the double strand drive, that is, the employment of two driven wheels side by side, each having spring compensating centers. The object of the spring compensating center device is to absorb the shocks and pulsations incident to a long heavy chain drive and to correct the errors of angular velocity, which is important in reciprocating machines. In the case of the double strand drive the compensating device also prevents unequal wear of the chains, balancing the load between them and making the wear equal.

Fig. 3 shows the spring compensating center clearly in detail for both a driving and a driven gear, the construction being essentially the same in both cases. It will be observed that one of the gears is shrouded or flanged at the sides while the other is plain. The one having the flanges at the sides is the driven gear, it being necessary in all cases to provide flanges for the driven gear, but this is not necessary for the driver save when the center distances are long. In Fig. 1 it will be noted that the pinions of the electric motors are plain, while the driven machines have flanged gears.

* * *

CENTENARY OF THE LOCOMOTIVE—1803-1904.

A. R. BELL.

One hundred years ago, on February 12, 1804, occurred an event which was without parallel throughout all the ages, in the results which accrued. On that day the first steam railway locomotive made a trip of nine miles along a tramway with a train containing a load of iron weighing 10 tons exclusive of the wagons, and 70 people, at a speed of five miles an hour (whilst traveling), though the actual journey, owing to slight accidents, extended over four hours and five minutes. The scene of the performance was the Pen-y-darren Tramroad, near Merthyr Tydvil in South Wales, extending from the back of the Plymouth works at Pen-y-darren to the Navigation at Plymouth. A wager laid between Samuel Homfray, the owner of the road, and his friend, Richard Crawshaw, in which £500 a side was staked on the possibility of conveying a load of bar iron by steam power from the works to the water side, encouraged the experiment to be undertaken. This wager was actually secured for Mr. Homfray by a Cornish engineer and mechanic, Richard Trevithick, who was at that time employed in erecting a forge at the iron works at Pen-y-darren, and who designed and erected the first practical railway locomotive at the company's works. Prior to that he had, in co-operation with his cousin, Vivian, patented the idea of a high-pressure steam engine—as distinguished from the low-pressure condensing engines then in use for mining operations—and had built a road locomotive in accordance with that idea, and a railway locomotive for use at Coalbrookdale. If the latter ever accomplished a trip along a railway is open to doubt. At all events, the Welsh engine is the earliest of which any authentic particulars are forthcoming as having fulfilled the purpose for which it was designed.

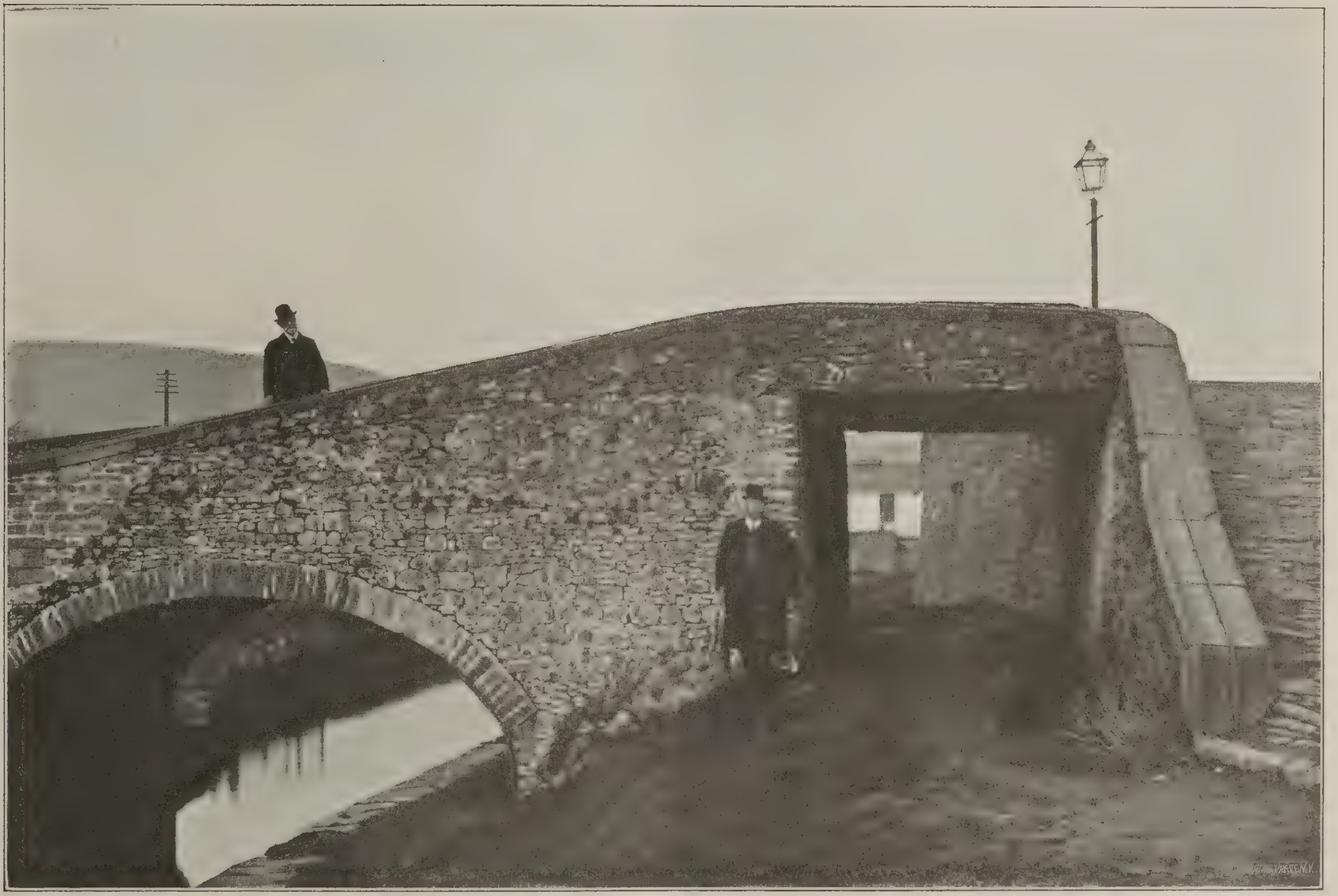


Fig. 1. On Feb. 12, 1803, the first locomotive made a trip of nine miles, taking four hours. The tramway passed under the old bridge shown above at Pen-y-darren, Wales, and the brick chimney of the locomotive was knocked down at this point

The patent taken out by Trevithick in 1802 specified an "improved steam engine to give motion to wheel carriages of every description." Passing over the details of the gearing designed to give forward or backward motion to the carriages at will, we find that a force pump was provided for feeding the boiler. An important item refers to the question of adhesion. Thus, while in certain cases it was suggested to make the external periphery of the wheels uneven, by projecting heads of nails or bolts, or cross grooves, or fittings to railroads, when required; or in cases of "hard pull" to cause a lever, bolt, or claw to project through the rim of one or both of the said wheels, so as to take hold of the ground"; yet it was specially mentioned that "in general, the ordinary structure or figure of the external surface of these wheels will be found to answer the intended purpose."

Referring to details embodied in the engines built by Trevithick, but not mentioned in the specification, the following occur. The boiler was cylindrical and contained an internal flue firebox, and return flue tube. The cylinder was partially contained within the upper part of the boiler, that portion which was not so contained being provided with a steam jacket. The waste steam after leaving the cylinder was taken into the chimney, and thus provided a steam blast. This point has often been misunderstood, since in the patent specification and in the earlier road locomotives, bellows worked from the piston rod or crank were provided for. There is no room for doubt, however, that in practice Trevithick was the inventor of the exhaust up the chimney. It has been said truly enough that "as a true inventor no name stands in so close connection with the locomotive engine as that of Richard Trevithick. It was he who first broke through the trammels of Watt's system of condensation and low, if not negative, pressure; it was he who first employed the internal firebox and internal heating surface; he was the first to create or promote a chimney draft by means of exhausting the steam through it; the first to employ a horizontal cylinder and cranked axle, and to propose two small cylinders with the cranks at right angles to each other; the first to surround the cylinder with hot air; the first to draw a load by the adhesion of a smooth wheel on a smooth rail bar; the first to make and work a railway locomotive engine."

The foregoing claims are in no degree minimized by the fact that Richard Trevithick failed to make a commercial success of any of the few locomotives that he designed and built. He was an inventor, and not a man of business, without the instinct that caused George Stephenson to battle against prejudice and conservatism until he won. Others reaped what Trevithick had sown, and the world at large always apt to credit those who succeed, is in danger of forgetting the debt which it owes to the Camborne engineer.

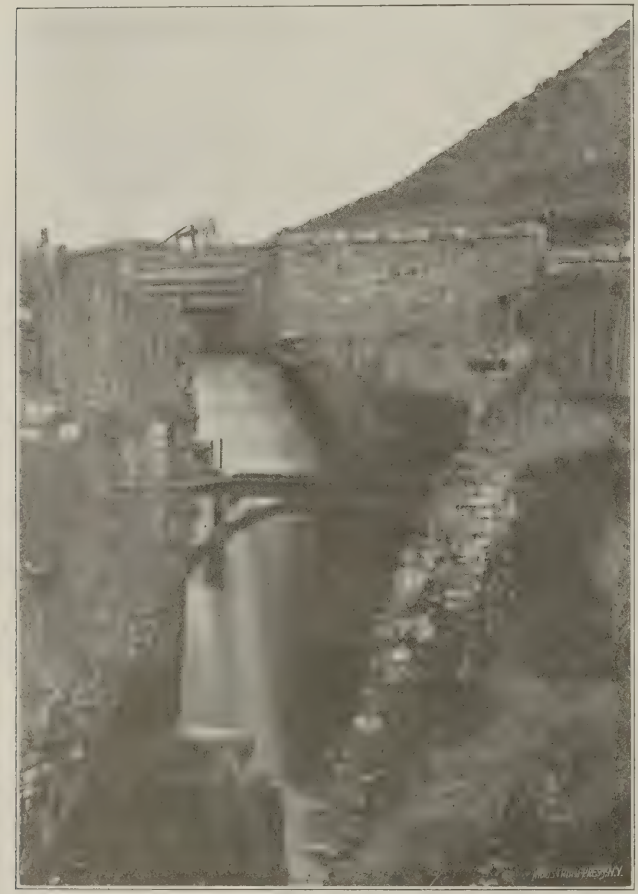


Fig. 2. An old Bridge on the Pen-y-darren Tramway.

Of the first railway locomotive, which won the wager for Samuel Homfray, it is unfortunate that no really authentic drawing seems to be in existence. The illustration, Fig. 5, which is generally assumed to be the Pen-y-darren engine, is derived from an original drawing made by Trevithick himself, and dated December, 1803. Such details as the return flue boiler, the small chimney, the horizontal steam jacketed cylinder and the smooth wheels can readily be seen, but generally accepted accounts of the engine built for the Merthyr train road speak of "a dwarf body placed on a high framework, constructed by the carpenter of the works in the roughest possible fashion. The wheels were equally rough and large, and surmounting all was a huge stack, ugly enough when it was new but in after times made worse by whitewash and rust." This chimney was built of brick, and it is stated to have collided with a bridge en route, promptly collapsing.

Richard Trevithick was born at Camborne in 1771 and died in 1833. His labors were chiefly among mining engines, and on these, as in the locomotive and steam engines generally, he left his mark. He is credited with the introduction of the Cornish and Lancashire type of boiler, the internal furnace, the non-condensing steam engine, the portable engine, the feedwater heater and boiler feed pumps, the locomotive and the blast pipe—a sufficient catalogue to make it seemly that his memory should be preserved green.

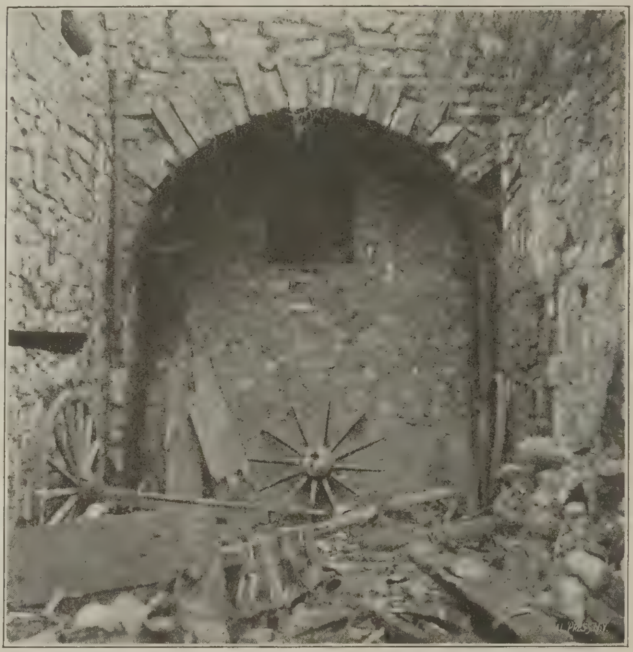


Fig. 3. Remains of Old Tunnel at Merthyr, through which Trevithick Locomotive ran on its Trial Trip—now used as a Store for Old Metal.

[The print sent by Mr. Bell showing "Trevithick's high-pressure tram engine" or locomotive, bears the following inscription, but, unfortunately, no date is given:

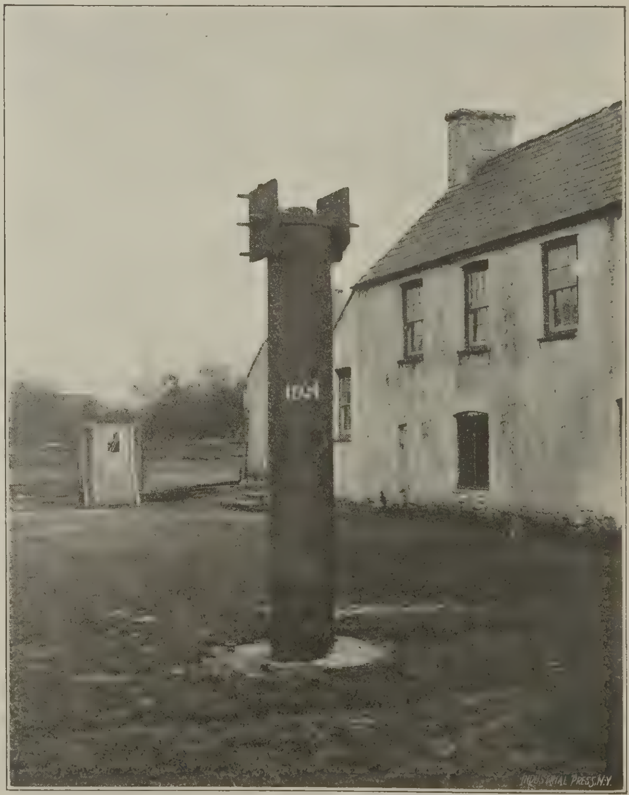


Fig. 4. Pillar of an old Crane, at Navigation—made in 1804 by Trevithick.

"Trevithick's high-pressure tram engine, so designated in the original plan, was constructed partly in Cornwall and partly at Pen-y-darren Works by Richard Trevithick, Esq., engineer for Samuel Homfray, Esq., proprietor of the Pen-y-darren Iron Works, Merthyr Tydvil, who, while discussing the principles and feasibility of locomotive steam engine power with Richard Crawshaw, Esq., of the Cyfartha Iron Works, made a bet of one thousand guineas that he could convey by steam power a load of iron from his works to the Navigation House (nine miles distant) along the basin tramroad; which he effected by this engine and won his wager although the heavy gradients, sharp curves, and frangible nature of the cast iron trackway operated against the return of this ingenious though rudely constructed machine with the empty trains—hence its discontinuance. As may be perceived, the exhaust steam discharged into the stack, and the wheels are combined; thus to Trevithick is the credit due for the application of those two principles to locomotive engines.

"Rees Jones, who aided in the fitting, and William Richards, its driver, are still alive [date not given]; the former when shown the plan, instantly identified it, and the latter, now in his 85th year, has worked no other than Trevithick's high-pressure engine. To this day portions of the old engine exist in the one he now works at Pen-y-darren, and during a period far beyond half a century, never having had an accident with his boiler.—Thos. Ellis, Engineer, Ty Mawr, Porty Prid, Glenmorganshire."—Editor.]

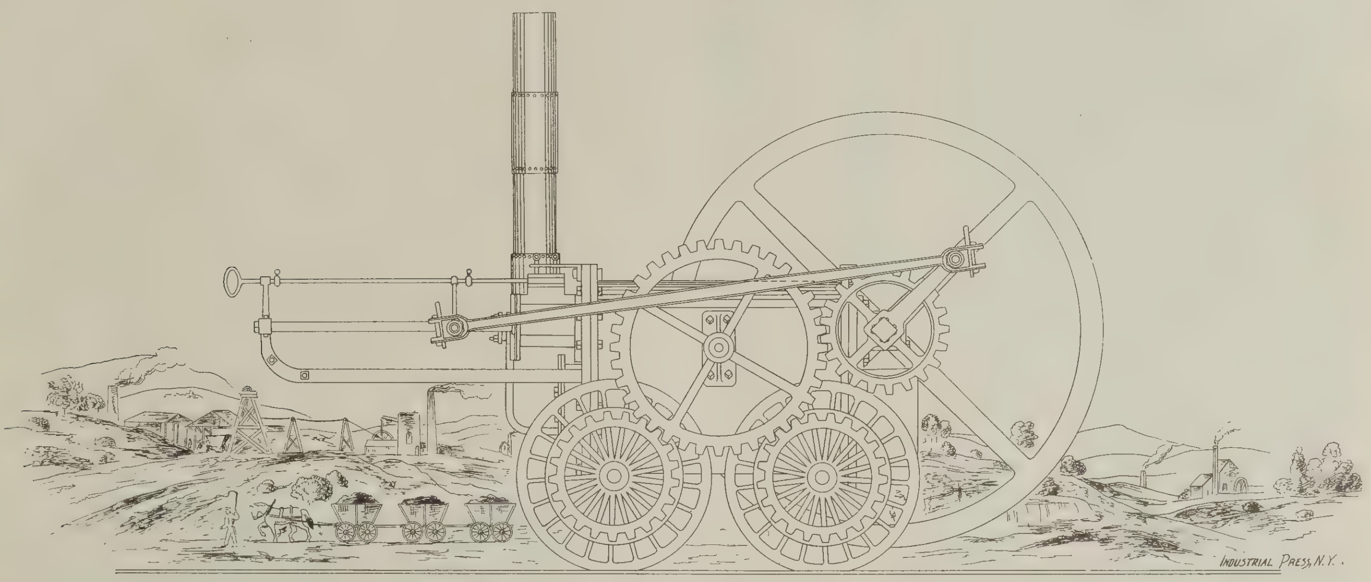

INDUSTRIAL PRESS, N.Y.

Fig. 5. Trevithick's "High-pressure Tram Engine. (From an old Drawing.)

* * *

One of the alleged difficulties of profitably operating street railways is that certain conductors will engage in the pernicious practice of "knocking down" fares. Whether the loss sustained by the railway companies is large in the aggregate as compared with the gross earnings, we have no means of knowing, but do know that the companies are continually devising ways and means for discouraging the practice. The fare register is universally employed, but this works only by the hand of the conductor, and if he is of the type that letteth not his left hand know what the right hand doeth, the register registereth not. To check this unprofitable practice—to the street railway companies—"spotters" are employed to travel as ordinary passengers and keep "tabs" on the conductors. It is alleged that the spotters on the Brooklyn Rapid Transit lines receive $2.50 a day each to spend for fares, in addition to their regular pay. This system of espionage is very irritating to employes and often works gross injustice; the spotters are expected to "earn" their wages, and if conductors are too honest the job of the spotter languishes. Hence there may be good basis for the allegation that false reports are sometimes made, whereby innocent men are made to suffer. Why could not the trading stamp plan be successfully employed by the street railway companies to promote honesty among their conductors? Let them give each conductor coupons equal in face value to the nickels he turns in. If these coupons were redeemed on about the same basis as the popular trading stamp the practice would supplement the other checks at small expense and might prove very popular with the men.

NOTES FROM THE PLUNGER ELEVATOR COMPANY.

NOVEL HYDRAULIC PRESS—THREE-WAY VALVE.

At the works of the Plunger Elevator Co., Worcester, Mass., there are two hydraulic presses for straightening the steel tubes used for the elevator plungers. In this type of elevator the steel cylinder is sunk perpendicularly in the ground, a hole first being driven by a process similar to that employed in driving oil wells. The cylinder is of a length equal to the total rise of the elevator; and the plunger, which is turned and polished on the outside, runs in this cylinder, being supported laterally only by the stuffing box at the top and a spring sliding support at the bottom of the plunger which keeps it central so that it will not rub upon the rough interior surface of the cylinder. The elevator is made to travel upward under the pressure of water pumped into the cylinder; and it travels downward when the water is allowed to escape from the cylinder. The car which is attached to the top of the plunger has a rigid support under it, consisting of the steel plunger and the column of water in the cylinder. The weight of the plunger is partially balanced by cables attached to the elevator which pass over sheaves at the top and from which counterweights are suspended.

For the successful operation of such an elevator, especially on high lifts, the plunger must be accurately finished, and it is necessary to remove the bends in the tubing before turning. In Figs. 1, 2 and 3 are views of the press used for this purpose, which is the design of Prof. Geo. I. Alden, formerly of Worcester Polytechnic Institute. The press combines the principle of the hydraulic press with that of the double toggle joint press, as shown clearly in the smaller photograph reproduced in Fig. 2. Referring to Fig. 3 the two hydraulic cylinders are supported at their inner ends by the pins connecting each pair of links at the center, and at their outer ends by the swinging links *L L*. The two pistons, one in each cylinder, are connected by a piston rod as in sectional view, Fig. 3, and the cylinders move horizontally upon the pistons under the influence of water pressure, causing the toggle joint to open or close, as the case may be. When water is admitted to the inner ends of the cylinders the cylinders move toward each other, bringing the links of the toggle joint together and forcing down the plunger of the press. When water is admitted to the outer ends the cylinders are forced apart, raising the plunger of the press. The extent to which the cylinders can move toward each other, and hence the distance that the plunger can move downward, are regulated by the screw and handwheels shown in the sectional view of Fig. 3. It is necessary, of course, to have a flexible pipe connection with the cylinders, and this is done by using lengths of wrought-iron pipe having swivel joints, as illustrated in the general view, Fig. 1.

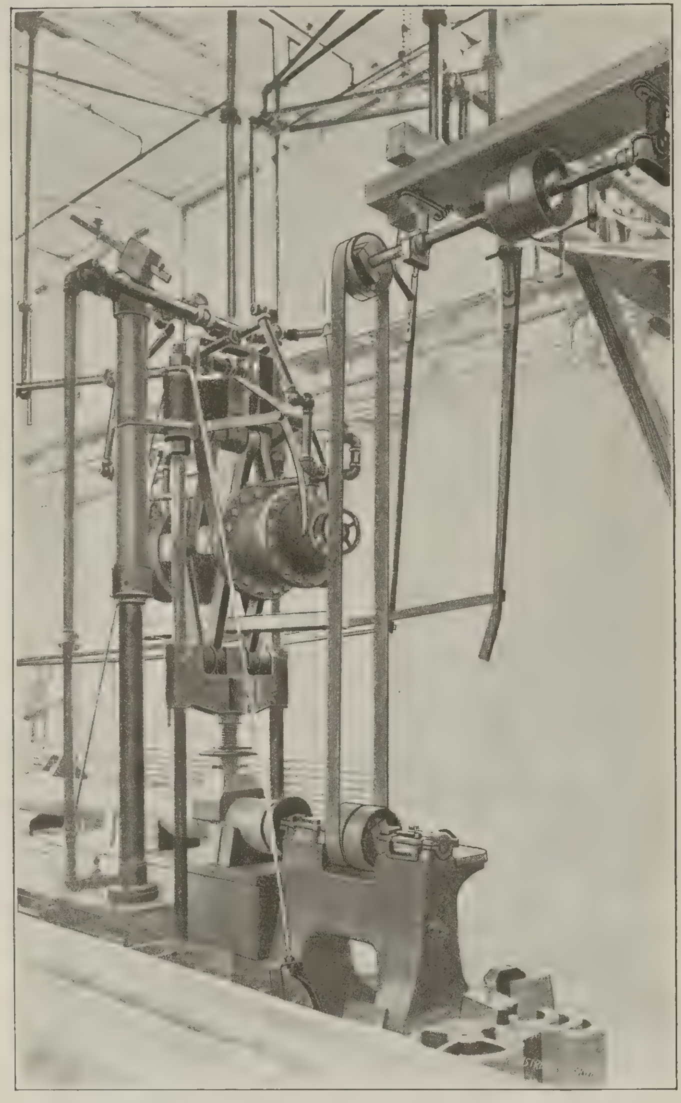
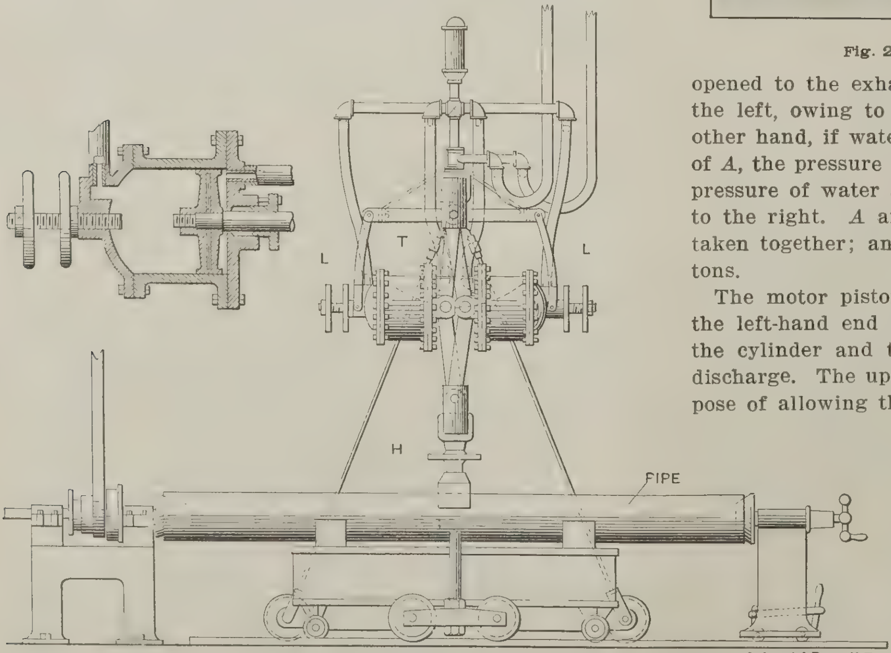


Fig. 1. Hydraulic, Toggle-joint Press.

The press operates under the pressure of an accumulator, which is shown in Fig. 1, at the left. The pipe to be straightened is supported upon cone centers, one of which is upon the spindle of a stationary headstock and the other upon a movable tailstock, so as to accommodate a pipe of any length. The pipe itself is supported upon a carriage which runs upon a track so that it can be located midway between the head and tail centers, and the press also travels upon a track so that the plunger can be brought to bear at any point on the pipe. These details are clearly brought out in Fig. 3.



Industrial Press, N.Y.

Fig. 3. Side View of Press.

Description of Three-way Elevator Valve.

The most interesting feature of the plunger elevator is the controlling valve by which water is admitted to, or discharged from, the cylinder. This valve is shown in Fig. 4, and is used in connection with two stop valves—one for the supply, and one for the discharge—which are actuated by the elevator when it reaches its extremes of travel at the top or bottom of the shaft. The controlling valve is actuated by the attendant in the car in the usual manner.

The valve has three openings—one at *E* to the supply pipe, one at *F* to the elevator cylinder, and one at *G*, which is the discharge or exhaust opening. There are three pistons, lettered respectively *A*, *B*, *C* and *D*, which are all connected. Pistons *B*, *C* and *D* are for the purpose of admitting water from the supply pipe to the elevator cylinder which occurs when they move to a position at the right, or for connecting the elevator cylinder with the discharge opening when the pistons are in a position at the left. When in mid-position, as shown in the engraving, water can neither pass to or from the elevator cylinder and the elevator is held at rest wherever it may be located.

These pistons *B*, *C* and *D* are moved to the right or left as required, by water pressure acting upon the two faces of piston *A* and the left-hand face of piston *B*. The space between *A* and *B* is always filled with water under pressure, which comes from the supply pipe *E*. Inasmuch as the diameter of *A* is larger than the diameter of *B* it is evident that if the space in the cylinder at the left of *A* (marked *R*) were opened to the exhaust, the four plungers would be forced to the left, owing to the unbalanced pressure upon *A*. On the other hand, if water were admitted to the space *R*, at the left of *A*, the pressure upon this piston would be balanced and the pressure of water against *B* would cause the pistons to move to the right. *A* and *B* may be considered as motor pistons, taken together; and *B*, *C* and *D* taken together, as valve pistons.

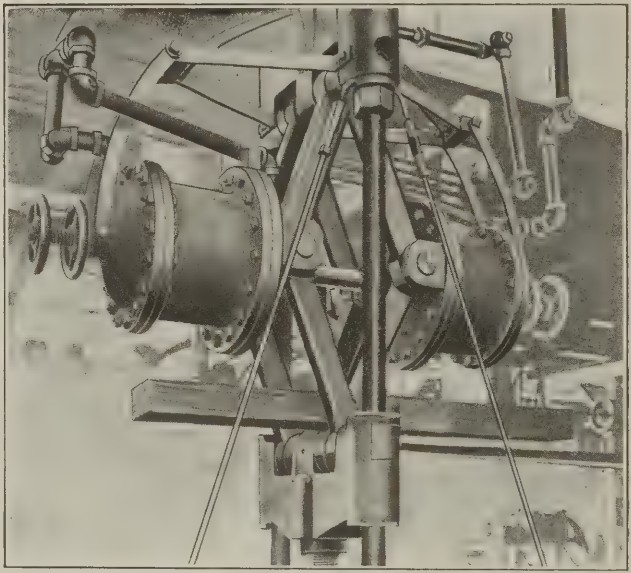
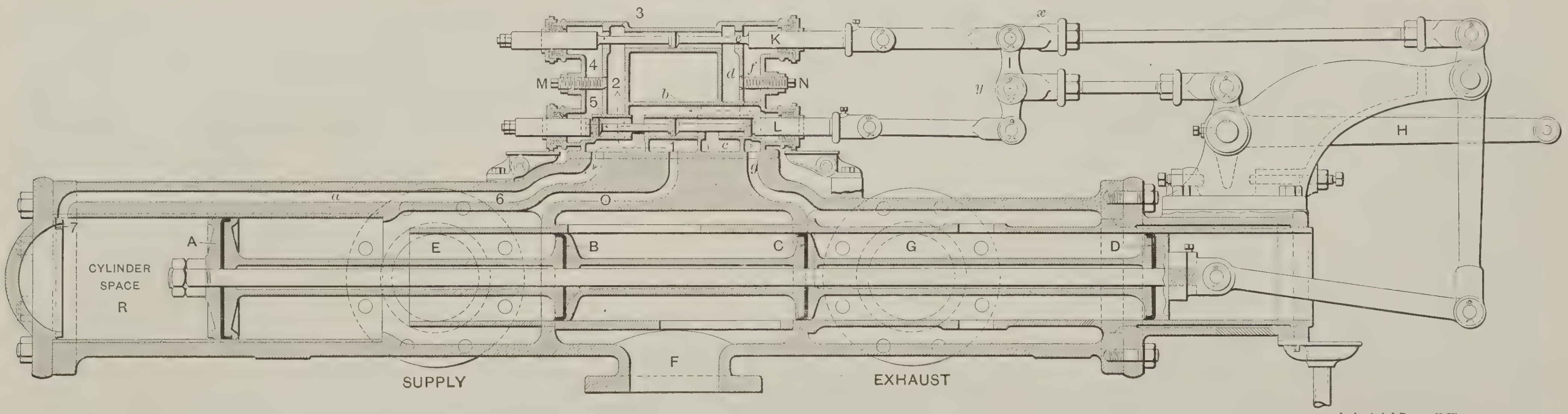


Fig. 2. Enlarged View of Head of Press.

The motor pistons are under the control of pilot valve *L*, the left-hand end of which regulates the supply of water to the cylinder and the right-hand end of which regulates the discharge. The upper valve *K* is a throttle valve, for the purpose of allowing the elevator to start rapidly, but compelling it to stop slowly. The sudden stopping of an elevator not only brings severe strains upon the mechanism, owing to the momentum of the parts, but also is extremely unpleasant for passengers because of the peculiar sensation that sudden stopping always produces. These objections do not hold to so great an extent, however, in starting an elevator, and it is desirable to bring it up to speed as rapidly as possible.



Industrial Press; N.Y.

Fig. 4. Three-way Valve for Elevator Control used by the Plunger Elevator Company.

(1.) The action of the various parts of the mechanism of this valve can be readily followed out with the aid of the reference letters and figures of the engraving. The handle *H* is under the control of the elevator boy, and is connected, by means of floating lever *I*, to the pilot valve *L*. The lever *H* is shown in its mid-position, but suppose it to be raised, causing the floating lever *I* to swing about point *x* as a pivot and move the pilot valve *L* to the left. The chamber marked 1, directly under this valve, always contains water under pressure, inasmuch as it is connected by the passage *O* with the supply *E*. Chamber 1 also connects with chamber 2 by means of a cored passage, as indicated by the arrow. The flow of water is as follows:

From 1 to 2, through valve opening at 3; to chamber 4 through the valve opening at 5, owing to the pilot valve having moved to the left; thence through the cored passage 6 to the end 7 of the cylinder. This produces a balanced pressure on the motor piston *A* and the water pressure between *A* and *B* acts upon *B* and forces all the pistons to the right. Water can then enter the elevator cylinder from *E*, through the openings in the cylinder uncovered by piston *B* to the port *F*.

It will be observed that the link connections are such that when these several pistons moved to the right throttle valve *K* moved to the left while pilot valve *L* moved back again to its middle position. When it reached middle position water was shut off from the cylinder, bringing the main piston to rest and allowing water to flow freely from the inlet *E* to the port *F*, causing the elevator to ascend. The movement of throttle valve *K* to the left, just referred to, closed the exhaust port *E*—the object of this being to compel the elevator to stop gradually when the handle is again moved to mid-position, as will shortly be evident.

(2.) Suppose lever *H* to be now moved back again to middle position, for the purpose of stopping the elevator. Floating lever *I* again pivots at *x* and pilot valve *L* is moved to the right. This allows the water in the cylinder at the left of piston *A* to escape as follows: It flows through the passage *a*, around the valve stem of the pilot valve to *b*; thence through the port just opened by the right-hand movement of the pilot valve to the chamber *c*; thence by a cored passage to chamber *d*. At this point the water, in order to escape, must flow into the passage *f*, but as the port *e* has been closed by valve *K* the water must pass through an opening partially closed by the setscrew *N*, which thus checks the flow of water, and it finally escapes through the passage *g* to the exhaust *G*. The water pressure at the left of *A* being thus relieved, the pistons travel slowly to the left. By the time the pistons have reached mid-position, as in the drawing, water is shut off from the cylinder, the pilot valve *L* is in mid-position, closing both the supply and discharge passages leading to the cylinder *R*, and the throttle valve *K* is in mid-position, with the two ports which it controls wide open, to allow free passage of the water, and thus a quick starting of the elevator, no matter whether it is traveling up or down.

(3.) Finally, suppose lever *H* to be moved downward. The pilot valve *L* moves to the right, as in case 2 above, only it moves twice as far, because it is in a mid-position at the start instead of in its left position. Water again flows from the cylinder, following letters *a*, *b*, *c*, *d*, *e*, *f*, and *g*, the pistons move to the left, the elevator cylinder is placed in communication with the discharge opening *G*, and the elevator descends.

The travel of the pistons, however, causes the auxiliary valves *K* and *L* to move as before until the exhaust passage from the cylinder is closed and the pistons come to rest with the elevator still moving downward until lever *H* is again brought to mid-position.

It will be seen from the above illustrations that whenever pilot valve *L* is displaced there is a corresponding movement of the pistons, the extent of this movement being determined by the distance and the direction in which the pilot valve has been moved, and that when the pistons come to the corresponding position their motion will have closed the ports controlled by the pilot valve, and the pistons will stop moving.

* * *

Hon. Wm. R. Grace, whose death occurred recently, had been president of the Ingersoll-Sergeant Drill Co. for fifteen years. At a meeting of the board of directors of the company, the board adopted a resolution whose purport was to express their sorrow at the loss of their president and friend and to extend to his widow and family their deep sympathy.

IMPROVEMENTS AT THE FORE RIVER SHIP & ENGINE COMPANY'S PLANT.

E. L. C.

In a former issue of MACHINERY we gave a description of the new plant of the Fore River Ship & Engine Company, Quincy, Mass. Since that time there have been many improvements and the works have been greatly extended. The original plant as first equipped was thought at that time to be one of the most modern and complete in its appointments of any of its kind, but recent inspection shows that many new and original ideas have been worked out, and that the position of this company has steadily advanced with the progress of the times.

They have under construction at this time the battleships *New Jersey, Rhode Island* and *Vermont*, and the protected cruiser *Des Moines*, for the United States Government, a side-wheel passenger steamer for the Fall River Line of the New York, New Haven and Hartford Railroad, a freight steamer and four large car floats for the same company.

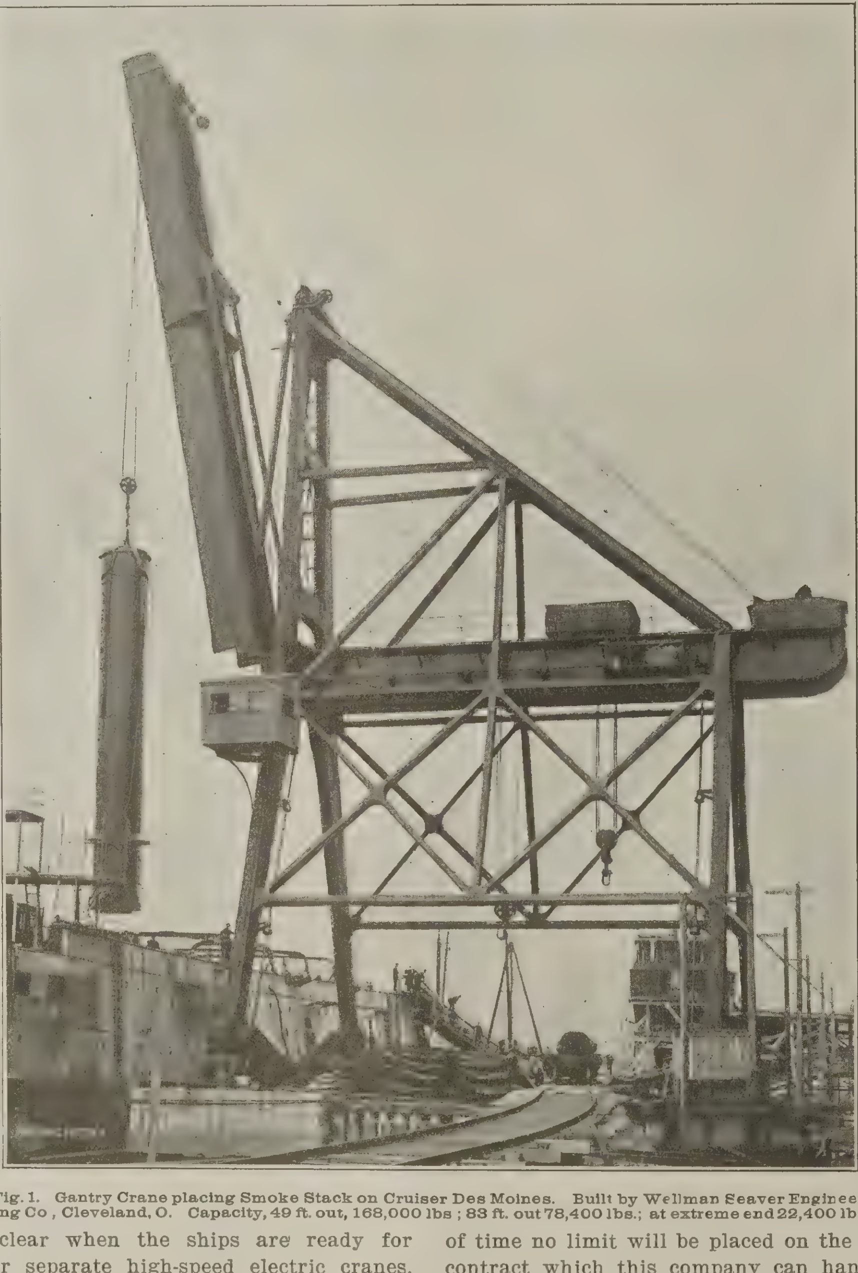


Fig. 1. Gantry Crane placing Smoke Stack on Cruiser Des Moines. Built by Wellman Seaver Engineering Co, Cleveland, O. Capacity, 49 ft. out, 168,000 lbs; 83 ft. out 78,400 lbs.; at extreme end 22,400 lbs.

The schooner *Thos. W. Lawson*, which has caused a commotion in shipping circles, being the largest vessel of the fore-and-aft rig in the world, and the only one having seven masts, was successfully launched and completed at these works, and caused the owners to at once intrust them with the building of another of nearly equal dimensions, and which has recently been launched and christened the *Wm. L. Douglass* and is now nearing completion at their new fitting-out dock.

Of the many improvements made at the yard the crane structure over the building slips now occupied by the battleships *New Jersey* and *Rhode Island* can be considered as one of the most important. This structure is 560 feet long and 180 feet wide, and of ample height to carry all weights clear when the ships are ready for launching. It has four separate high-speed electric cranes, two over each ship. These cranes have a capacity of five tons each and any two can be used at the same time on a weight of ten tons, taking in any location on either ship. While these cranes are rated at five tons each, their capacity can be worked much higher with safety, and by referring to next page two of these cranes can be seen transferring the stern-post casting of the battleship *Rhode Island* over the ship to place at the stern. This casting is of steel and weighs fourteen tons.

Another great improvement now nearing completion is the fitting out dock, which is about 1,200 feet long, giving ample room to accommodate several large ships. A gantry crane traveling the length of this dock has a capacity of 40 tons, a distance out of 80 feet and 15 tons at the extreme end of boom. Some idea of the scope can be seen by referring to Fig. 1, showing it in the act of placing one of the smoke-stacks of the cruiser *Des Moines* in position. With the aid of this crane the fitting out of all classes of ships is made an easy matter.

Besides these improvements there has been added to the machine shop an area equal to the original size, now making room to handle work of the largest size with ease. To the ship tool shop they have added an immense area and fully equipped it with tools of modern design, and each tool has been supplied with one of their new-design handling tables, which increases their output with much less cost for labor, and is shown in Fig. 4.

Other buildings for foundry, angle smith, galvanizing and other minor branches have been added, which has called for a much larger and more powerful power plant, and to this department an addition has been constructed and fitted with boilers, engines and a large-sized air compressor of 5,000 cubic feet of free air per minute.

Their storage yard, which is 150 feet wide by 1,200 feet long, is covered by an electric crane, and this yard is connected by tracks to the main line at East Braintree. Their own locomotives are used to haul material to the yard, where it is taken from the cars and carried to any point of storage by the above-mentioned crane. This crane is of ample capacity to handle all material which may arrive.

These, with many other minor improvements, have now placed the Fore River Ship & Engine Company in a position to handle a large amount of work in an easy and profitable manner, and in a short space of time no limit will be placed on the amount and size of the contract which this company can handle.

The yard and shops of the Fore River Ship & Engine Co. have been so much enlarged and so thoroughly equipped since the formation of the company a few years ago that the plant ranks as one of the four most important private shipbuilding plants in the east, and one of the largest in the country. In approaching the works the most conspicuous structure is the steel frame work that has been built over the ways, on which the largest ships are constructed. Unfortunately this is not so located that a photograph can be taken of it, and the view in Fig. 3 merely shows a section of the frame work

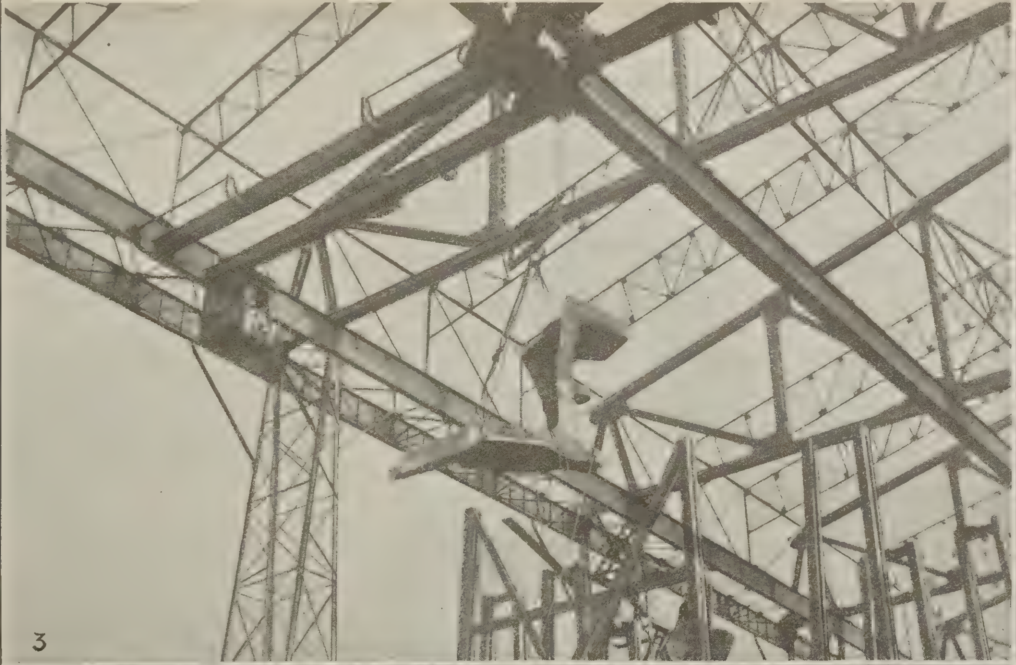


Fig. 3. Taking Stern post of Battleship Rhode Island over top of Ship to place, by two Electric Cranes in Crane Structure.

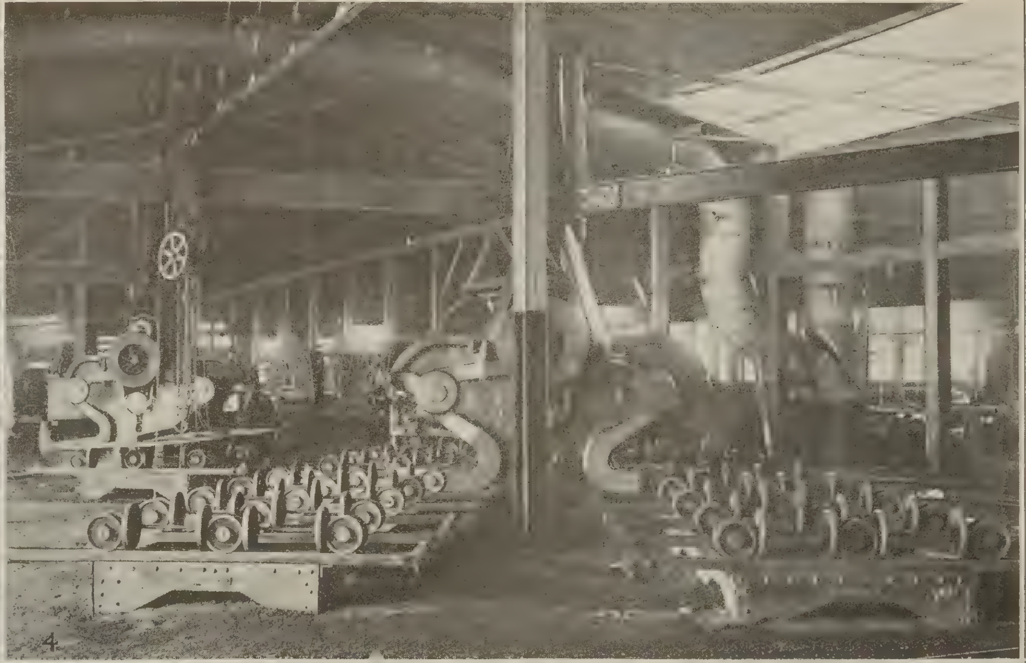


Fig. 4. Showing Improved Method of Handling Large Plates at Punches. Tables Invented and Patented by Fore River Ship & Engine Co.

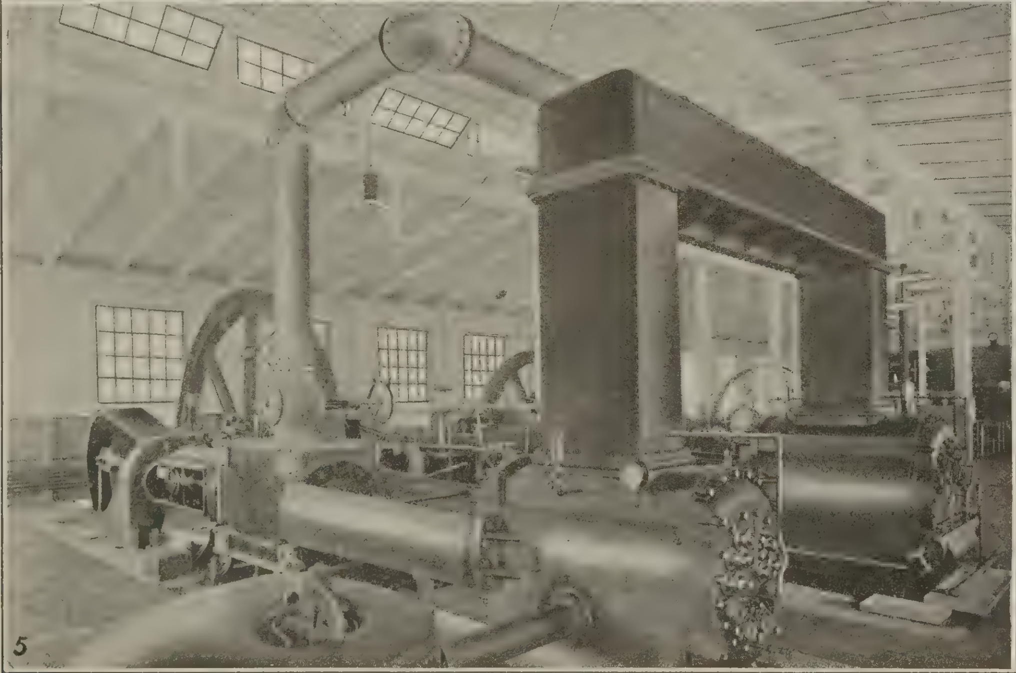


Fig. 5. Newly installed Air Compressor in Power House. Capacity, 5,000 ft. Free Air per min. Size of Steam Cylinders, 26 ins. and 48 ins. by 48 ins stroke. Size of Air Cylinders, 24 ins. and 40 ins. by 48 ins. stroke. Revolutions, 65 per minute, maximum

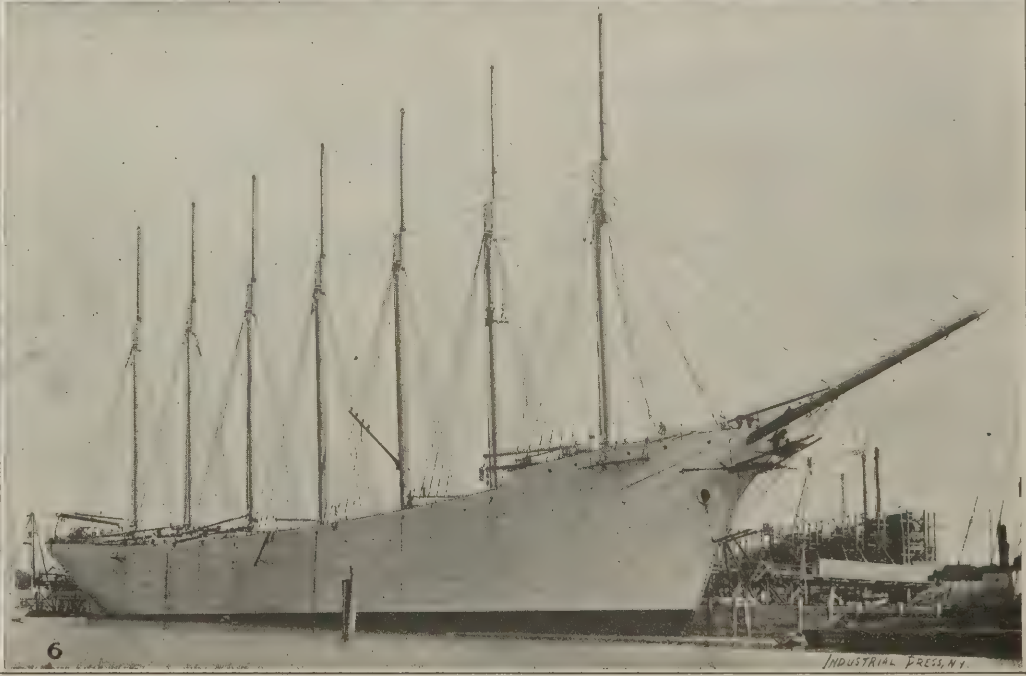


Fig. 6. Seven-masted Schooner Thomas W. Lawson, built by Fore River Ship & Engine Co. Three hundred and forty feet long, 8,000 tons Capacity.

photographed with the camera pointing upward from underneath. The steam hammer in the forge shop shown in Fig. 2 is one of the heaviest tools in the place, and is employed in forging ingots up to 5 feet in diameter and some 12 or 15 feet long. The cylinder of the hammer is 40 inches diameter, 10 foot stroke, and the hammer itself weighs 17 tons. Steam follows throughout the stroke at 100 pounds pressure.

The equipment of the ship tool department is unusually complete; the punches, rolls, etc., being for heavy duty. One set of rolls is 35 feet long, and there are punches heavy enough to punch the openings in the floorplates used in the frame work for ships, at one operation. The yard where the structural material is handled is served by a crane traveling on raised tracks and having 160 feet span. In the previous article on these works by our contributor information was given upon the equipment of the original machine shop, which has since been extended and there was also a description of the various buildings, including the large mould loft. In the shop equipment are several heavy lathes for turning and boring marine engine shafts, which we have previously illustrated and these, as well as the other tools about the whole plant, are driven by the Bullock multiple voltage system.

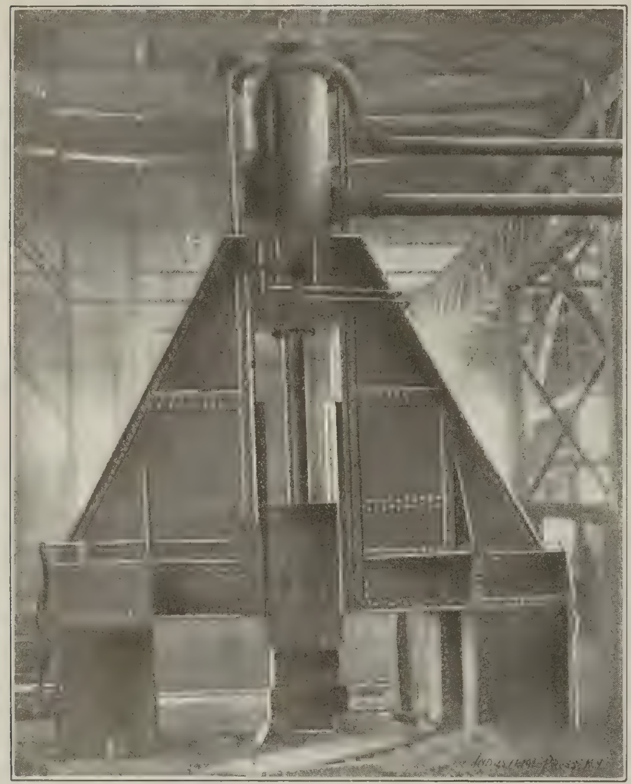


Fig. 2. Steam Hammer in Forge Shop. Cylinder 40 ins. by 1 ft. stroke, working under 110 lbs. Steam Pressure.

The plant is equipped for the building of a ship complete, including the hull, machinery, the forgings, boilers, and the cabinet work for the interior finish of the ship. In the latter department there is in use an ingenious machine for the production of wood beadings, moldings, etc., such as are used for the trim in the saloons, staterooms, etc., of a vessel. These are formed under pressure by rotary dies which are heated by electric current to the point where they will nearly but not quite char the wood. This machine is used under a royalty and the firm is not allowed to sell the products which it produces.—Editor.

* * *

A recent consular report refers to a German wood fireproofing process developed by Mr. Gautsch, of Munich, which is said to be very successful. The timber to be treated is placed in a vacuum, produced by pumping out the air. The cells are thereby freed of air and the wood is then impregnated under pressure with a solution of sulphate of ammonia and borax ammonia. The color, texture, or density of the wood is not affected thereby. The process renders it fireproof and proof against decay.

EXTRAORDINARY SHAFT SINKING WITH THE JUMP DRILL OR TREPAN.

The use of the so-called jump drill is limited in the United States to the drilling of small bores for oil, salt, artesian wells, prospecting for minerals and similar purposes where a large diameter is not required, the diameter of the bores being rarely greater than 12 inches and usually less than 8 inches. But where mining operations are to be conducted, shafts must be sunk and this work is done by laborious process requiring much manual labor, even if assisted by power drills and good hoisting facilities. Shaft sinking by the ordinary means is at best difficult work, but when a shaft penetrates strata containing water in large quantities, it becomes still more difficult and often impossible because the flow of water is so great that it is out of the question to pump it as fast as it flows in. In general this limit is reached when the flow of water reaches 800 to 900 gallons of water per minute at an average depth of 150 to 180 feet. For this reason there are great coal measures in Great Britain, containing many thousand millions of tons of coal that have never been worked, that is, because of the impossibility of sinking shafts through the water-logged strata overlying them. The Kind-Chaudron process of shaft sinking, however, promises to make the working of such mines possible and probable, and partially for this reason, but more because of the novelty and magnitude of the apparatus, we present herewith an abstract of an interesting article on the subject that appeared in a recent issue of the *Colliery Guardian.*

The only practicable method for solid rock where the quantity of water exceeds that stated above, is the shaft-boring process invented by Mr. Kind. In the Kind process of shaft sinking the water is allowed to rise in the shaft to its natural level. The whole work of deepening the shaft proceeds under water by means of a boring apparatus suspended by rods, the whole work of sinking being managed from the surface. The quantity of water, therefore, is quite immaterial, the shaft sinking progressing with the same speed whether the rocks to be pierced are water-bearing to an excessive degree, or whether they only carry small quantities. A pit is bored by means of a heavy borer called a trepan, which is the same diameter as the shaft to be bored. This borer is lifted to a certain height and then made to drop, crushing the rocks by knocking against the bottom of the shaft.

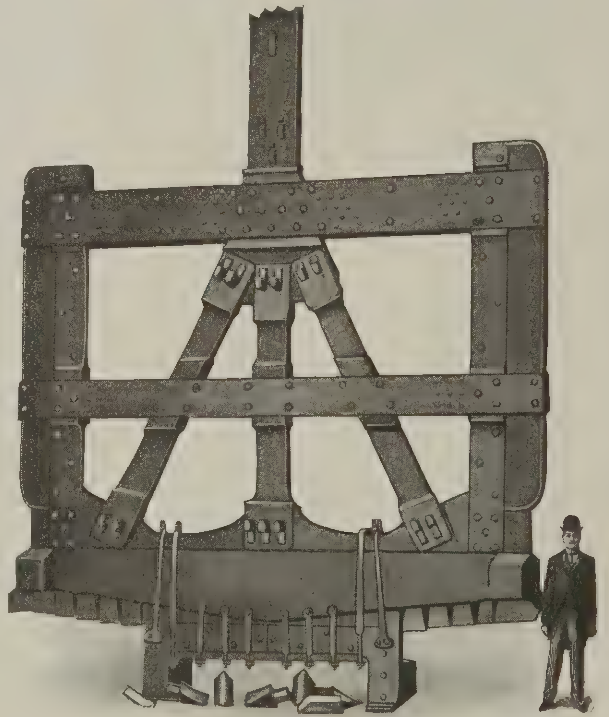


Fig. 1. Eighteen-foot Jump Drill or Borer, weighing 25 tons.

The illustration, Fig. 1, shows the construction of such an instrument, weighing about 25 tons and boring a hole 18 feet diameter, which has been used for recently-bored shafts. The design of this trepan, introduced by the firm of Haniel & Lueg, at Dusseldorf, has proved everywhere a success, and has shown a great resisting power even against the hardest rock. The working parts proper of the borer are the so-called teeth, which consist of best quality tool steel; the ironwork giving the necessary percussion weight. The illustration, Fig. 2, shows a borer weighing about 12 tons, made to the latest design of Haniel & Lueg's construction, of the usual diameter of 8¼ feet. This small borer working in advance of the large heavy borer is exclusively intended to deepen the so-called pre-shaft, which receives the debris formed during the boring with the main trepan, thus preventing the chief boring being impeded by the dust.

Fig. 3 shows the arrangement by means of which both the large and the small borers do their work. A wrought iron balance beam *m*, about 9 tons in weight, is connected at its aft end, by means of a chain similar to a Gall's chain, to a steam piston controlled by hand and moving in the so-called batting cylinder *l*. Another chain of the same kind as stated above joins the fore-end of the beam *m* to the wooden boring rods *f*, and by these to the borer at the bottom of the shaft. If by the movement of the controlling lever steam is admitted on the top of the steam piston in the cylinder *l*, the boring rods *f* with the borer are lifted by the beam; if steam now escapes, the borer drops back by its own dead weight to the bottom of the shaft, breaking up the rocks by the steel teeth. After every percussion the borer is turned through a small angle by means of the wooden lever *o* turned by four workmen, who stand on the boring platform, so that every blow of the borer will strike another part of the shaft bottom.

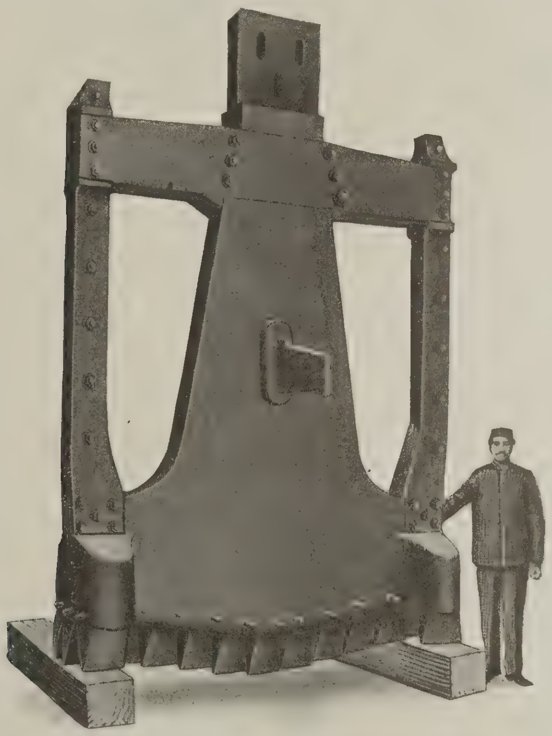


Fig. 2. Twelve-ton Borer.

The foregoing description will sufficiently prove the necessity of boring a pre-shaft. Working with the large borer only, so much debris would speedily accumulate in the bottom of the shaft that the effect of the blows would become almost inoperative. But the small borer having drilled at the middle of the bottom a kind of bowl to receive the rock crushings, these latter all fall down into the pre-shaft, thus preventing the chief borer from being impeded by the debris. The operation proceeds alternately in such a manner that the pre-shaft advances first for about 30 yards, the large borer following as far as possible. The debris amassed in the pre-shaft are brought to the surface by means of the mud-box *c*, Fig. 4, also called mud-spoon. This is a cylinder of about 6 feet diameter and about 1,350 gallons capacity, which is let down the shaft by means of the haulage rope. This mud-box being tossed repeatedly up and down, the muddy drillings will enter the box through the two bottom flaps, and the winding engine brings the filled mud-spoon to bank. Three boxes of mud per hour can be raised from a depth of about 180 yards.

Fig. 4 illustrates the wooden boring rods *f* as well as the adjusting screw *n*, the latter being used for lengthening the boring rods corresponding to the advancing depth. One rotation of the adjusting screw *n* corresponds to an elongation of the boring rods by ½ inch. Every time the adjusting screw has finished, it is screwed up again and a suitable lengthening piece is inserted.

It must be understood that the borer is not suspended from absolutely stiff rods, but at the top of the borer there are arranged what are termed "sliding-scissors," and above them a joint piece is inserted, which intermediate pieces render harmless the inevitable transverse vibrations of the rods. The small borer with sliding-scissors is seen in Fig. 4 at *b*. At the same time these sliding-scissors (while the borer is falling down) make it possible for the rods to continue their own independent motion, and to move down by some inches after the borer has struck against the bottom of the shaft. This so-called play of the sliding-scissors can also be observed at the balancing beam *m*, and at the batting cylinder on the surface, and indicates all events and occurrences that happen at the bottom of the shaft during the boring process. Further, you may know by its gradual decrease the degree of progress of work.

The impetus moving the rods downward when the borer falls is reduced to nought by means of a dash-catcher erected on the surface, which the balancing beam bounds against, after the borer has struck the bottom, at the same time the scissors come into play. By this means the rods are also brought to rest.

The advance boring is made with the free-falling apparatus. The principle of the free falling depends on the borer being raised with a great swiftness by means of the balancing beam, but this motion upwards is suddenly stopped by an obstacle lying under the extreme end of the beam, towards which the latter rebounds. The upward motion of the borer, rods, etc., is interrupted by this sudden stoppage, too; but the movable parts of the free-falling apparatus, especially the wooden shield, do not participate in the sudden check of the whole, but continue the motion upwards by their inertia, when the borer, rods, etc., have already come to a standstill; hereby the two catching hooks are hooked off and the borer falls down absolutely free. In each case this manipulation is the work of a moment.

The free-falling apparatus constructed by the firm of Haniel & Lueg has been perfected to so high a degree, and the action of the catching and hooking-out mechanism is so exactly regulated, that it has been found possible, by way of trial, to perform forty-five strokes per minute with a borer weighing about five tons only. But on an average we can estimate about thirty strokes per minute with a borer of the latest construction weighing about twelve tons. With the 25-ton borer or trepan the number of strokes is about twelve to fifteen per minute, the reduction number being necessary to give the workmen time to turn it around.

Shaft boring through the water-bearing strata continues until the borer reaches a formation which is quite certain to carry no water. In boring coalpits in Germany generally the green sand lying under the white marl is chosen to shut out the water. In England generally the coal formation itself may be chosen to finish the shaft boring in the absence of certain impervious permian strata. If in this rock which is free from water the shaft is deepened by boring about 30 yards more, then the boring work proper is finished, and means have got to be taken to dam out the water from the watery strata passed through. For this purpose, Messrs Haniel & Lueg manufacture solid cast iron shaft rings, each made in one piece, and these rings when built up on one another form the so-called cuvelage. This cast iron cuvelage was invented by Mr. Chaudron. The outside diameter of these shaft rings is about one foot smaller than the diameter of the large borer, thus being one foot smaller than the bored shaft. The flanges of these undivided rings are machined with the greatest exactness, so that the cuvelage makes an absolutely tight dam at the joints.

The thickness of these cast iron rings depends on the depth they are intended to be sunk to, i. e., on the outside water pressure they have to withstand; thus the weights of the single rings vary between 5 and 18 tons. Now, as about sixty or seventy rings are required for a depth of about a hundred yards, the total weight of the cuvelage ordinarily exceeds several millions of pounds. It is obvious that no rope, chain nor headgear would be capable of supporting such enormous weights; and, therefore, in order to enable the rings to be put in, it is arranged to do this by tightening the lowest but one ring provisionally, by means of a cast iron bottom of the strongest construction to keep out water from below. This bottom causes the column of the cuvelage rings to float in the water of the shaft.

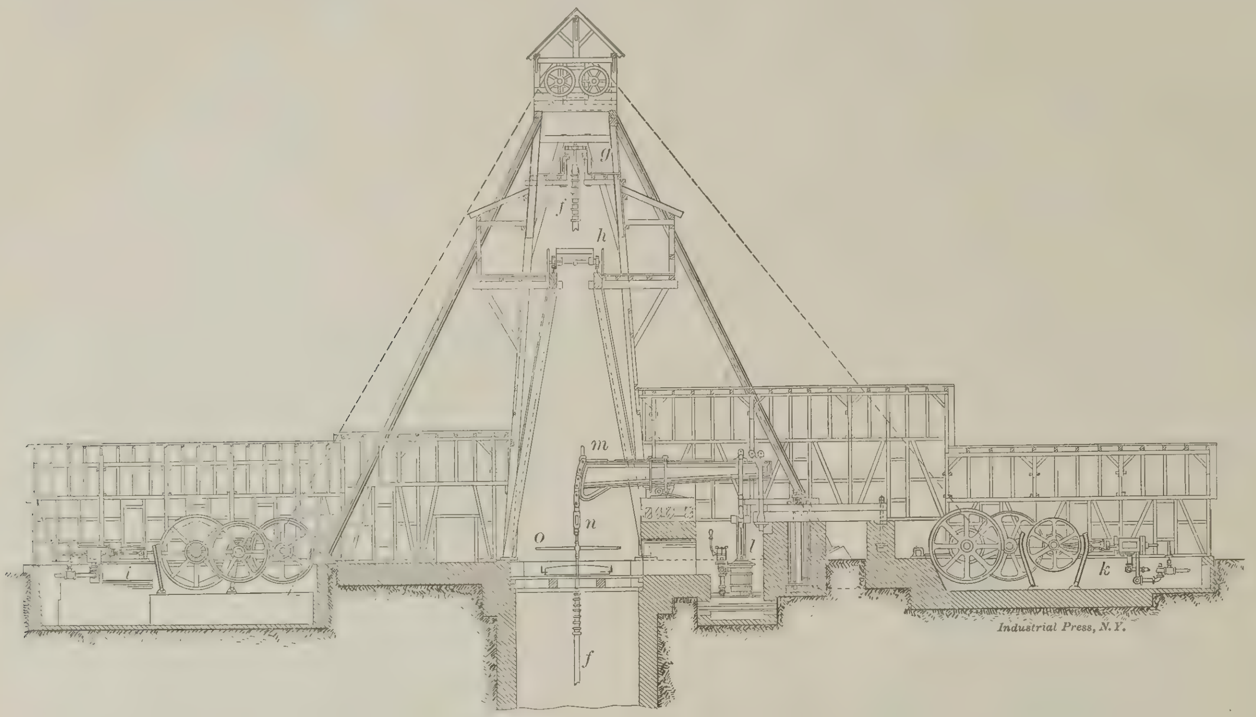


Fig. 3. Method of Actuating the Borer.

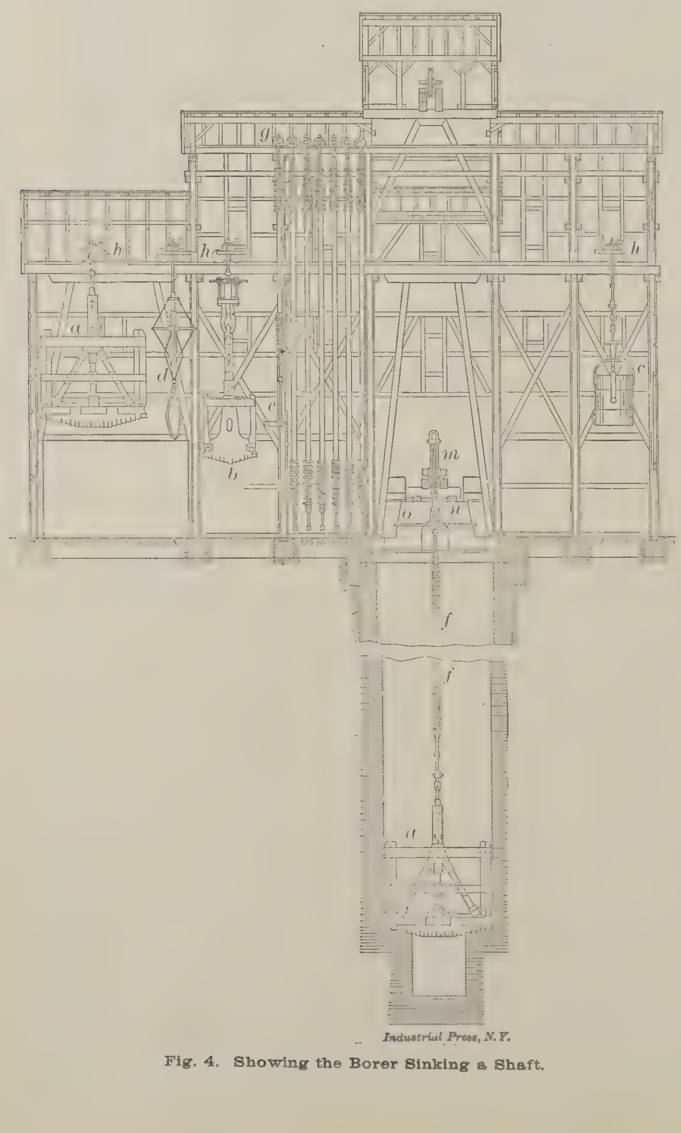


Fig. 4. Showing the Borer Sinking a Shaft.

On the surface more rings are now continually built to the top of the first floating shaft rings, and in order to make the whole sink further, after having screwed up another ring, so much ballast water is let into the floating cuvelage that the cuvelage already joined together sinks in each case until the top flange of the top ring stands some yards above the surface of the water. This process is continued until the lowest ring reaches the bottom of the shaft. Thus a cast iron cylinder stands in its entire length in the bored shaft. It has already been proved possible to sink down twenty-two rings in twenty-four hours, thus making watertight about 40 yards of the shaft in one day. The horizontal joints between the single rings are tightened by means of sheets of lead about 1/8 to 1-10 inch thick; these sheets are tightened to the utmost when the iron rings are bolted together.

The lowest ring is constructed in a different manner from the ordinary ones. It consists of two rings intended to telescope, thus forming a stuffing-box—the so-called moss-box. The packing material of this stuffing-box is moss or some other soft material rammed closely in the stretched moss-box and enclosed by a hemp net, so that the moss, etc., cannot tumble out of the box. When the moss-box, after the descent of all the rings, has reached the bottom of the shaft, more ballast water is pumped into the cuvelage, by which the box is telescoped, and consequently the moss comes under a strong pressure, so that the hemp net tears and the moss is driven out all round the rocky shaft walls. As the lowest part of the shaft, which the moss-box is to be set in, is supposed to be free from water, the moss compressed to the utmost between box and face of the shaft prevents any access of the water standing on the outside of the cuvelage to the bottom of the shaft. An outlet is given, however, to the water standing below the cast iron bottom of the cuvelage by a cast iron pipe rising in the center of the cuvelage to the surface, by which the water, having no outlet, escapes when the moss-box is driven together.

The water of the water-bearing overlying strata being cut off for the present, provision must be made for the final shutting out of this water by filling up with concrete the space between the outside of the cuvelage and the rocky shaft wall in its whole length. After the concrete is hardened, the ballast water is drawn out of the shaft, the cast iron bottom loosened and brought to the surface, and now it is possible to sink the shaft further in dry formations. A shaft 18 feet in diameter was sunk by this process near Hanover, Germany, 165 yards in one and one-half years, the net cost being about $180,000.

ALTERNATING CURRENT CRANE MOTORS.

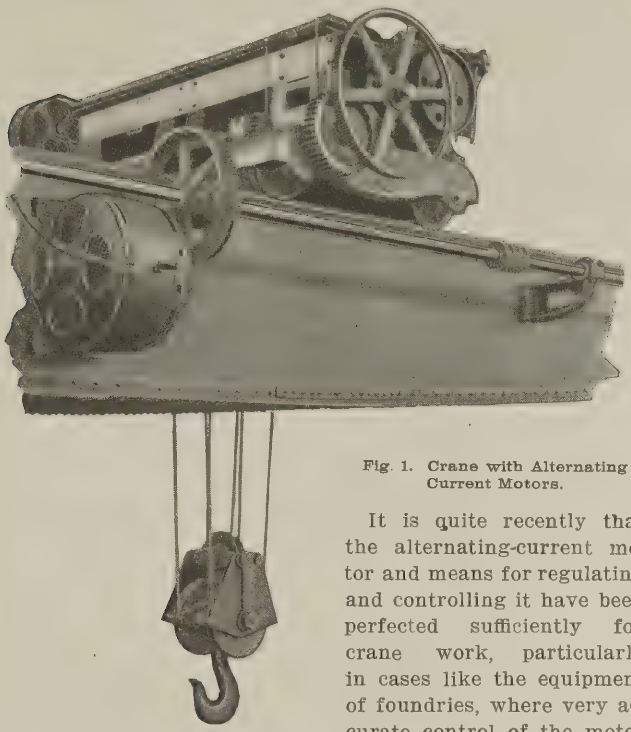


Fig. 1. Crane with Alternating Current Motors.

It is quite recently that the alternating-current motor and means for regulating and controlling it have been perfected sufficiently for crane work, particularly in cases like the equipment of foundries, where very accurate control of the motor is absolutely necessary to enable the handling of heavy molds, the withdrawal of patterns from the mold, etc. It cannot be doubted, however, that the alternating-current motor is making successful inroads upon the field of the direct-current motor, not only for driving machinery, but for crane service as well, and the advantage that it appears to have is in the direction of simplicity and durability under severe usage.

A plant is cited by the Westinghouse Electric Manufacturing Company that was equipped four years ago with forty of their crane induction motors, and which now has eighty of these motors. The cost of motor repairs has been only sixty dollars for the entire period, although the cranes are heavy and have been in constant and severe service.

The alternating-current crane equipment includes Type C variable-speed motors for the trolley, bridge, hoist and auxiliary hoist, two auto-transformers, one controller for each motor, and one electric brake for the hoist motor. The motor is without commutator, brushes or other moving contacts or wire, which parts are the most frequent causes of trouble in direct-current service. It will stand almost any amount of overloading without injury to its windings, and may also be reversed when running at full speed. In carrying material about a shop it sometimes happens that a crane must be quickly stopped to avoid a collision of its load with some unexpected obstacle. In such cases the bridge motor has been reversed at full voltage without damage, which indicates the amount of abuse this type of motor will stand in service. Variations in speed are secured by changing the voltage impressed on the motor, which is accomplished by two auto-transformers operated by a thirteen-point controller giving twelve speeds in approximately equal steps.

The auto-transformers perform the same service as the usual controller resistance—they cut down the line voltage to a value suitable for the speed requirements of the motor. There is, however, an important difference in the efficiency obtained by the resistance and the auto-transformer control methods. In the former a comparatively large amount of energy is wastefully dissipated in the resistance, whereas with the latter method only a trifling amount of energy attends the reduction of the voltage. An auto-transformer is a transformer having a single winding. It is connected across the line and delivers current at either of several different voltages, depending on which of the terminals distributed along its winding is connected to the motor.

Two auto-transformers supply all of the motors for a single crane. They are proportioned to meet the collective demand for current which may be made by the simultaneous action of all of the motors, but this circumstance is so infrequent in its occurrence that comparatively small auto-transformers suffice. The controllers designed for regulating and reversing these motors have a large number of steps for regulation, and are conveniently operated by a lever connected by a link to the controller arm. The controller is of the face type of construction, simple in design. The base is a slab of slate mounted on a cast-iron frame. Upon its surface are arranged contact segments of rectangular hard rolled copper bar. Each segment has two finished surfaces, and when one surface becomes damaged the segment may be reversed and the other surface used. The controller brushes are made of hard-rolled copper bar.

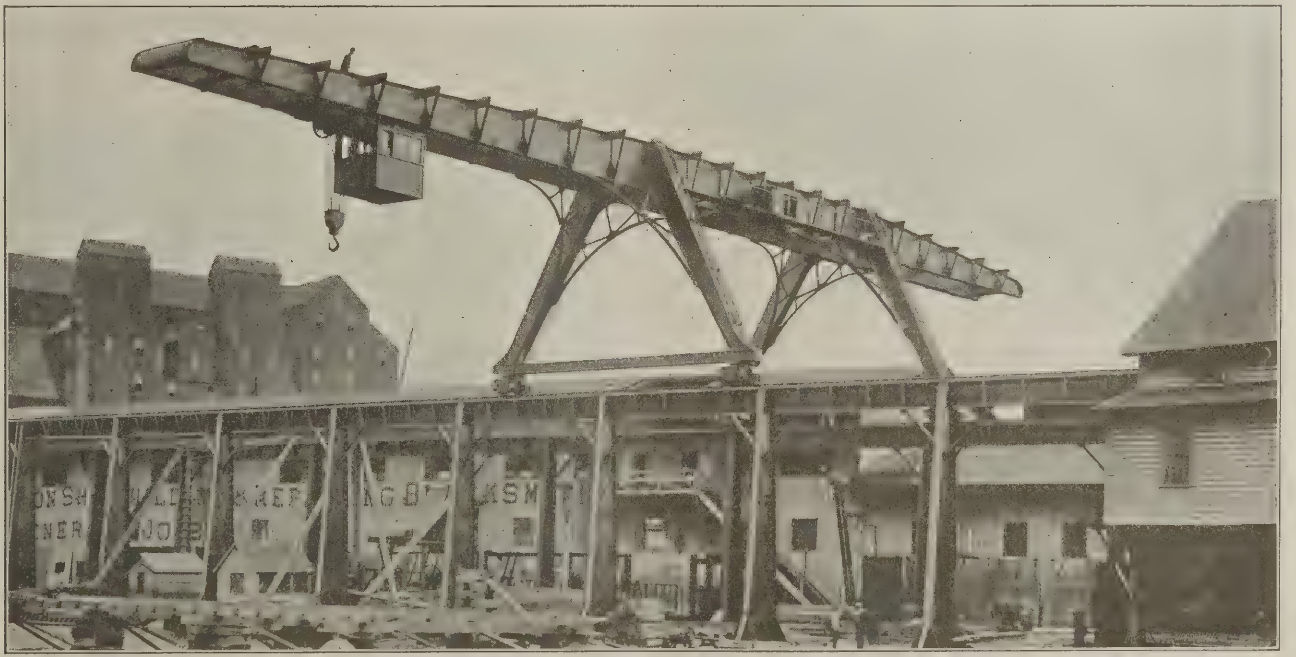


Fig. 2. Elevated Traveling Crane of the Gantry Type Operated by Alternating Current.

One of the novel features of an alternating-current crane is the use of alternating current for the brake magnets. The action of the alternating current magnet may be stated in general to be the same as that of an ordinary direct current solenoid magnet, but its construction is not to be as lightly approached. The peculiarities of the alternating current make the design of a successful magnet a difficult problem. The magnet consists of two U-shaped magnets having the limbs of their U's in a vertical position with coils surrounding each limb. The upper U is fixed and supported by a bracket bolted to the motor. The lower U, which is known as the armature, moves upward when attracted by the fixed part, and falls when released, the movement being rigidly transmitted to the brake shoes by a bell-crank lever. When the magnet is energized, the armature is lifted, releasing the brake shoes; and when the circuit is opened, the armature falls, applying the brake shoes to the brake wheel. This automatic action is clearly apparent from the illustration.

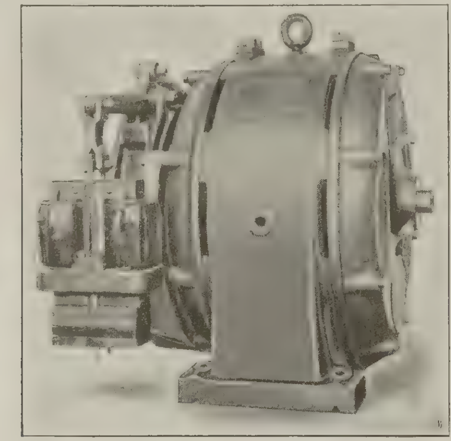


Fig. 3. Alternating Current Crane Motor with Alternating Current Magnet Brake.

The magnet itself is controlled by a small switch mounted upon the face of the controller. When the controller is moving off the first notch, the magnet switch is closed, and current flows through the winding, energizing the magnet. When the controller moves to the off position the magnet switch opens and the armature falls by gravity, and should the power fail while the crane is hoisting, the brake would immediately set and prevent the load from falling.

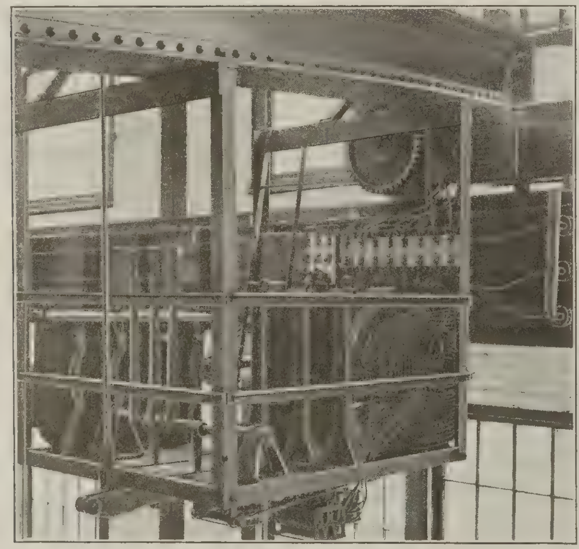


Fig. 4. Controller and Connections.

* * *

A novel form of dam has been built in Germany over the River Main, which provides for the rapid discharge of floods, the whole upper part of the dam being raised bodily above the flood level. It consists of a hollow steel cylinder 115 feet long and 6½ feet diameter, having teeth or cogs on its periphery at each end. These teeth engage in racks, fixed in the masonry side walls, which are vertical at the lower ends but inclined to an angle of about 45 degrees at the upper ends. The rotation of the cylinder by suitable means, causes it to roll up the inclined racks to such a height as may be necessary to clear the water. The steel plates forming the cylinder are 1.1 inch thick and its total weight is 193,600 pounds. Electric power is used for raising and lowering, suitable reduction gearing being provided so that an 18 horse power motor can raise the dam to a height of 13 feet above the sill in about fifteen minutes.

AN AIR LUBRICATED JOURNAL.

ARTHUR W. COLE.

When one considers the question of lubrication he naturally thinks of oils as the lubricating agent. This is without doubt because for many years oils have been the chief lubricant in use in the arts. The fact is, however, that there are other substances which occur in nature, that have been shown by experiment to be as good if not better than oil. The substances to which we refer are the air and the water.

During the last few years water has been used for the purpose of lubrication in the arts chiefly in the tailshaft bearing of ocean steamships. The construction of these bearings allows the water to circulate freely about the shaft, thus keeping the bearing flooded and affording good lubrication. Water is also circulated around the main bearings of the engine, where it aids the oil by conducting away the heat caused by the friction of the moving parts.

The lubricating possibilities of air, also, have long been recognized, as, for example, its action between two well-fitting surface plates, but it was not until some three or four years ago, when experiments were conducted at the Worcester Polytechnic Institute, that its possibilities in this direction were actually demonstrated in connection with cylindrical bearings.

The apparatus as mounted for the purpose of demonstrating this property of air is shown in Fig. 1, and also in Figs. 2 and 3. The essential parts are the cast-iron ring or sleeve *R*, and the steel plug or short piece of shaft *P*. The plug is six inches in diameter, six and one-quarter inches long, and its weight fifty and one-half pounds is the load on the bearing. The bore of the ring and the cylindrical surface of the plug are carefully finished by grinding so that they are very nearly true cylinders. The diameters of the two surfaces differ on the average by about .0016 inch. The sleeve is closed at one end. Two valves V and V^1 are provided; one of which is opened to permit the escape of air while the plug is being inserted. When in place, the plug is about ¾ of an inch from the head; then, the valves being closed, the end motion of the plug is limited by the confined air. The plug is set in rotation by means of the wooden handle *H*. Higher speeds are obtained by an ordinary geared hand drill, shown at the right in Fig. 1, the slot in the iron plate in the end of the handle *H* being adapted to fit the hand drill.

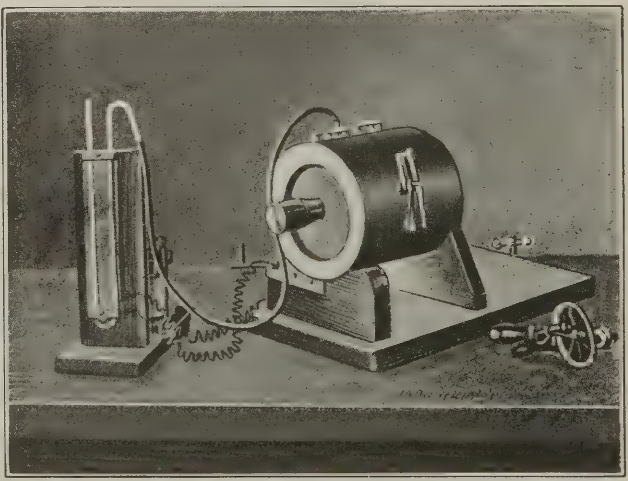


Fig. 1. Apparatus for Testing Journal

The ring *R* is mounted on a wooden frame as shown so that it may be turned about its axis, bringing any one of the test holes which are numbered from 1-6 into any desired position. The setting is made by the graduations on the face of the ring.

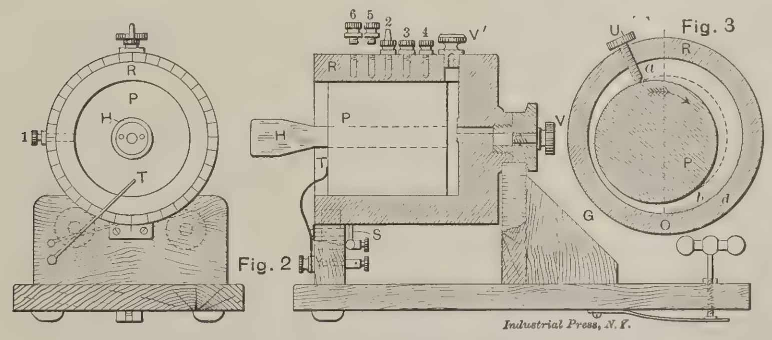
The auxiliary apparatus shown at the left of Fig. 1 consists of a mercurial manometer which may be connected with any one of the test holes by a rubber tube and nipple; also a galvanic cell with a bell in circuit, one terminal being in contact with the ring at *S*, Fig. 2, while the other terminal may be brought into contact with the plug at *T*.

When the plug *P* is at rest its weight is supported by metallic contact between the plug and the ring. This fact is evidenced by a grating sound if the plug is turned very slowly from its position of rest, and also by the ringing of the electric bell if the wire *T′* is placed against the plug. However, if the plug is revolved more rapidly, an entire change of conditions ensues; the grating sound is no longer heard, and if the wire be placed against the plug the bell does not ring as before. This fact is positive proof of the existence of the film of air about the revolving plug, as is the case when perfect lubrication exists with other fluid lubricants, by virtue of the viscosity of the lubricating fluids and the adhesion of the surfaces of the bearing.

The small difference in diameter of the bore and the plug as above explained is essential to the formation of the film and the separation of the surfaces. Still this film when formed is not of the same thickness at all parts, that is, the plug is not in the center of the hole. This is shown by inserting a small screw through the hole marked No. 1, as shown at *U*, Fig. 3. While the plug is revolving, the screw is turned until it touches the plug, as shown at *a*, the contact being determined by the ringing of the electric bell. If without further adjustment of the screw, the ring is turned slowly to the right, the contact is lost but is found again when the screw comes into position of *b*. Should the ring be turned in the opposite direction, the contact increases, as shown by the increased energy in the ringing of the bell. This shows that the plug is not revolving in the center of the bore and that the surfaces are nearest together at a point *G*, found by bisecting the arc *a b*. This may be verified by placing the screw in contact with *G* and turning the ring both to the right and the left from this position. In either case the contact will be at once broken.

The position which the point *G* takes on the circumference of the bore varies with the speed of rotation, that is, the axis of the plug and bore tend to approach each other as the speed increases.

The position which the plug takes within the bore implies that there is an unequal distribution of pressure in the air film. In order to determine this distribution of the pressure in the lubricating film of air, a nipple is screwed into one of the test holes; from it a small rubber tube leads to the mercurial manometer described above. By turning the ring to bring the hole into any desired position, the pressure may be noted at any point about the bearing. In this manner it is found that there is a negative pressure at the top of the bearing and a positive one at the bottom. By this we mean that the pressure at the top was found to be less than that of the atmosphere and at the bottom, greater. It was observed in this experiment that the decrease of pressure at the top of the plug is nearly equal to the increase at the bottom.



Figs. 2 and 3. Details of Apparatus.

From experiments with the air-lubricated journal, it must be concluded that the lubricating agent in all journals where perfect lubrication exists is distributed in a similar manner to the air film in the above tests.

The existence of a positive and negative pressure in the film shows us at once the place in which the lubricant should be admitted to the bearing. If in the above case, a hole should be made at the point of greatest positive pressure, it is obvious that the air would flow in at the first opening and out at the second. Therefore, if a lubricant is to be fed automatically into a journal the opening for inserting it should be made at the point where the pressure at the most is no greater than the atmosphere and no openings should be made where the pressure is above the atmosphere. These conditions are easily fulfilled in a bearing in which the pressure is always in the same direction; changes in the direction of the pressure will, however, greatly complicate the problem.

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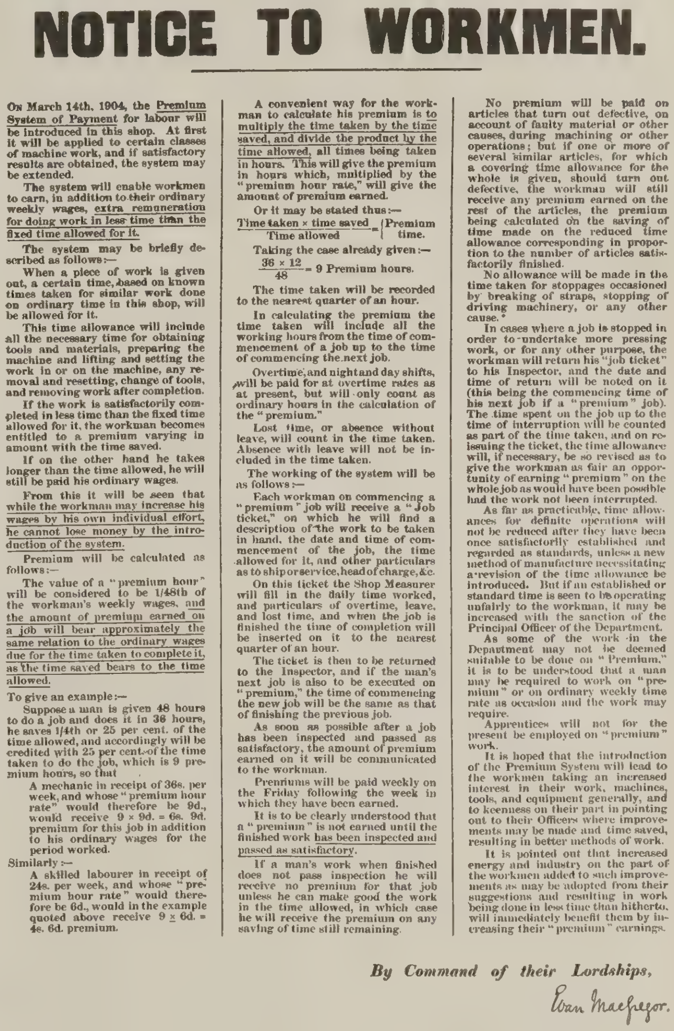
PREMIUM SYSTEM IN ROYAL NAVY SHOPS.

On the 14th of March the British Admiralty adopted the premium system for the shops connected with the various dock yards, and the accompanying notice, reproduced from



NOTICE TO WORKMEN.

On March 14th, 1904, the Premium System of Payment for labour will be introduced in this shop. At first it will be applied to certain classes of machine work, and if satisfactory results are obtained, the system may be extended.

The system will enable workmen to earn, in addition to their ordinary weekly wages, extra remuneration for doing work in less time than the fixed time allowed for it.

The system may be briefly described as follows:—

When a piece of work is given out, a certain time, based on known times taken for similar work done on ordinary time in this shop, will be allowed for it.

This time allowance will include all the necessary time for obtaining tools and materials, preparing the machine and lifting and setting the work in or on the machine, any removal and resetting, change of tools, and removing work after completion.

If the work is satisfactorily completed in less time than the fixed time allowed for it, the workman becomes entitled to a premium varying in amount with the time saved.

If on the other hand he takes longer than the time allowed, he will still be paid his ordinary wages.

From this it will be seen that while the workman may increase his wages by his own individual effort, he cannot lose money by the introduction of the system.

Premium will be calculated as follows:—

The value of a "premium hour" will be considered to be 1/48th of the workman's weekly wages, and the amount of premium earned on a job will bear approximately the same relation to the ordinary wages due for the time taken to complete it, as the time saved bears to the time allowed.

To give an example:—

Suppose a man is given 48 hours to do a job and does it in 36 hours, he saves 1/4th or 25 per cent. of the time allowed, and accordingly will be credited with 25 per cent. of the time taken to do the job, which is 9 premium hours, so that

> A mechanic in receipt of 36s. per week, and whose "premium hour rate" would therefore be 9d., would receive 9 × 9d. = 6s. 9d. premium for this job in addition to his ordinary wages for the period worked.

Similarly:—

> A skilled labourer in receipt of 24s. per week, and whose "premium hour rate" would therefore be 6d., would in the example quoted above receive 9 × 6d. = 4s. 6d. premium.

A convenient way for the workman to calculate his premium is to multiply the time taken by the time saved, and divide the product by the time allowed, all times being taken in hours. This will give the premium in hours which, multiplied by the "premium hour rate," will give the amount of premium earned.

Or it may be stated thus:—

$$\frac{\text{Time taken} \times \text{time saved}}{\text{Time allowed}} = \left\{ \begin{array}{c}\text{Premium}\\ \text{time.}\end{array}\right.$$

Taking the case already given:—

$$\frac{36 \times 12}{48} = 9 \text{ Premium hours.}$$

The time taken will be recorded to the nearest quarter of an hour.

In calculating the premium the time taken will include all the working hours from the time of commencement of a job up to the time of commencing the next job.

Overtime, and night and day shifts, will be paid for at overtime rates as at present, but will only count as ordinary hours in the calculation of the "premium."

Lost time, or absence without leave, will count in the time taken. Absence with leave will not be included in the time taken.

The working of the system will be as follows:—

Each workman on commencing a "premium" job will receive a "Job ticket," on which he will find a description of the work to be taken in hand, the date and time of commencement of the job, the time allowed for it, and other particulars as to ship or service, head of charge, &c.

On this ticket the Shop Measurer will fill in the daily time worked, and particulars of overtime, leave, and lost time, and when the job is finished the time of completion will be inserted on it to the nearest quarter of an hour.

The ticket is then to be returned to the Inspector, and if the man's next job is also to be executed on "premium," the time of commencing the new job will be the same as that of finishing the previous job.

As soon as possible after a job has been inspected and passed as satisfactory, the amount of premium earned on it will be communicated to the workman.

Premiums will be paid weekly on the Friday following the week in which they have been earned.

It is to be clearly understood that a "premium" is not earned until the finished work has been inspected and passed as satisfactory.

If a man's work when finished does not pass inspection he will receive no premium for that job unless he can make good the work in the time allowed, in which case he will receive the premium on any saving of time still remaining.

No premium will be paid on articles that turn out defective, on account of faulty material or other causes, during machining or other operations; but if one or more of several similar articles, for which a covering time allowance for the whole is given, should turn out defective, the workman will still receive any premium earned on the rest of the articles, the premium being calculated on the saving of time made on the reduced time allowance corresponding in proportion to the number of articles satisfactorily finished.

No allowance will be made in the time taken for stoppages occasioned by breaking of straps, stopping of driving machinery, or any other cause.

In cases where a job is stopped in order to undertake more pressing work, or for any other purpose, the workman will return his "job ticket" to his Inspector, and the date and time of return will be noted on it (this being the commencing time of his next job if a "premium" job). The time spent on the job up to the time of interruption will be counted as part of the time taken, and on reissuing the ticket, the time allowance will, if necessary, be so revised as to give the workman as fair an opportunity of earning "premium" on the whole job as would have been possible had the work not been interrupted.

As far as practicable, time allowances for definite operations will not be reduced after they have been once satisfactorily established and regarded as standards, unless a new method of manufacture necessitating a revision of the time allowance be introduced. But if an established or standard time is seen to be operating unfairly to the workman, it may be increased with the sanction of the Principal Officer of the Department.

As some of the work in the Department may not be deemed suitable to be done on "Premium," it is to be understood that a man may be required to work on "premium" or on ordinary weekly time rate as occasion and the work may require.

Apprentices will not for the present be employed on "premium" work.

It is hoped that the introduction of the Premium System will lead to the workmen taking an increased interest in their work, machines, tools, and equipment generally, and to keenness on their part in pointing out to their Officers where improvements may be made and time saved, resulting in better methods of work.

It is pointed out that increased energy and industry on the part of the workmen added to such improvements as may be adopted from their suggestions and resulting in work being done in less time than hitherto, will immediately benefit them by increasing their "premium" earnings.

By Command of their Lordships,

Evan Macgregor.

the poster announcing the introduction of the system, contains particulars that will be of interest to many readers. The poster was first reproduced in *Page's Magazine* (English), from which we have made our illustration. Those interested in shop systems can get out their reading glasses and see what "His Majesty's" ideas of profit sharing are.

* * *

What any particular service is worth in cold cash depends on the exigencies of the case and largely upon the position of the creditor to enforce his demand. Not everyone, however, is as favorably situated in both particulars as a Connecticut motorman is reported to have been recently. It seems that he is something of an expert in opening safes that baffle their owners and that he had been employed by a Torrington firm to open a safe which contained all their money and books. After a few minutes *skillful* work the safe door swung open, whereupon the motorman expert demanded $5 for the job, which was refused on the ground of being too much. He immediately closed the safe door, locked it and walked away, leaving the owners "in the hole," or rather outside the safe, and according to last accounts they are still there. Probably an expert from the safe factory would have presented a bill for a day's time and traveling expenses.

THE MAKING OF A SHUTTLE CARRIER.

A LITTLE INFORMATION UPON SEWING MACHINE WORK.

H. ROBINSON.

The method employed in the making of shuttle carriers for sewing machines varies considerably, as in the making of other parts. It is governed and depends on the following conditions: 1. The shape of the shuttle carrier, which varies, more or less, with every different type or make of sewing machine; 2. The quantity to be made, consequently the justifiable sum to be expended on tools, as well as their durability; 3. The machinery in the factory, where the tools are to be made, must be worked in; 4. Toolroom facilities where the tools are to be made; 5, The amount of time the "management" department allows for designing, making of the drawings, and building them; and finally, 6. The intelligence, or the lack of it, as well as the prejudices of the factory help, who are to handle them, as well as their "boss," who always knows or thinks he knows, more than the "collar-and-cuff" dude in the drawing office.

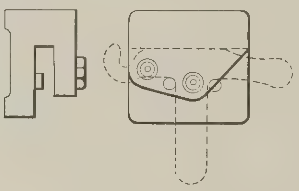


Fig. 10

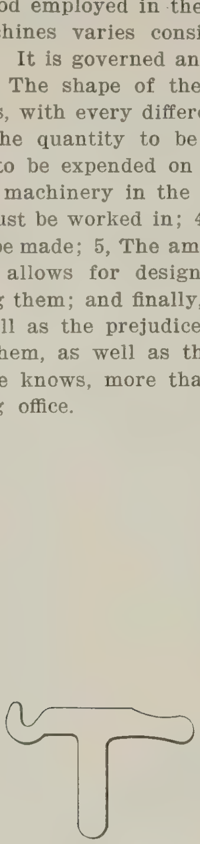


Fig. 1

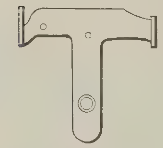


Fig. 3

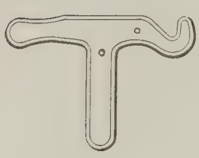


Fig. 2

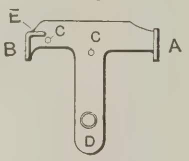


Fig. 4

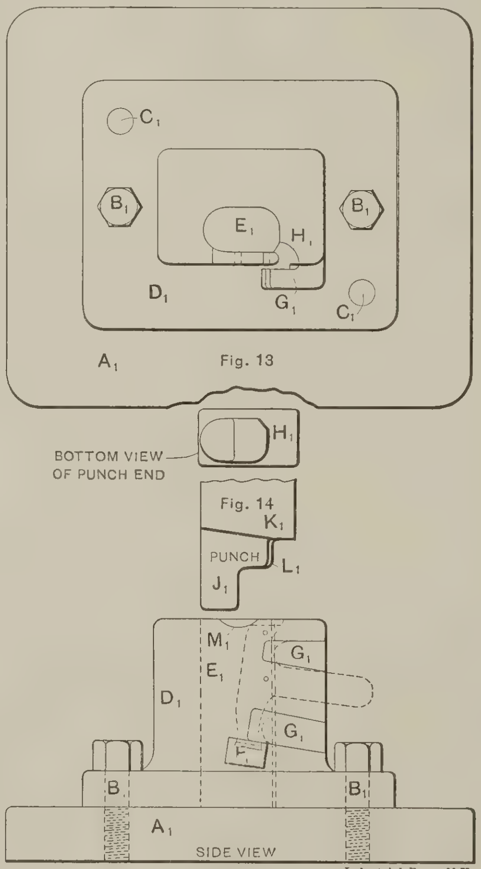


Fig. 13

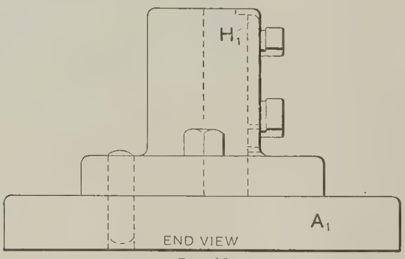


Fig. 13

Industrial Press, N.Y.

In the accompanying illustrations, Figs. 1 to 4 inclusive are intended to show the method employed in the making of a shuttle carrier for a certain type of sewing machine newly put on the market under a "you-can't-get-it-out-too-quick-or-too-cheap" condition, and for an unknown quantity. A finished shuttle-carrier is shown in Fig. 4. It is made of cold rolled steel 1-16 inch thick, the outer edge is rounded, the end *A* is bent at right angles, while the opposite end, *B*, has a double bend in it as shown. It also has two small holes *C C* for riveting on a flat spring and one tapped hole *D* for the connection with the shuttle-carrier lever. With the tools here described it takes six machine operations to bring it into that shape.

The first operation is cutting out the body, as shown in Fig. 1, and is done in a stamping press, with a punch and die, as shown in illustrations, Figs. 5 and 6, which blanks the bodies of the carriers out of a strip of cold rolled steel. This, of course, is done in a way to insure the greatest economy in the material, as in Fig. 7, which shows a piece of strip of the steel after the blanks have been punched from it. The body of the die *L*, Fig. 5, is a block of tool steel of sufficient thickness to prevent its springing while in operation. The cutting sides of the opening *J* taper inwardly about 0.001 inch to the depth of about ⅜ inch to insure the die keeping its size, approximately after repeated grinding, while the rest of the depth of the opening is tapered considerably more, to facilitate the egress of the punchings from the die. The stripper *H* is planed out at the bottom to act as a guide *K* for the steel to be punched, and the top port heavy enough to strip the waste from the punch without bending. It is fastened to the die block with screws and dowels *E F*, only on one side, the other side being left open to facilitate its operation. The gage pin *G* is sufficiently removed from the extreme cutting edge, to permit the arrangement of the punching, as shown in Fig. 7, which is done by punching one row first, then turning the strip over, and punching the other row between. The punch, *M*, Fig. 6, is milled out from a solid block of steel, the size of the flange. This is better practice than planing the punch across and fitting it in a flange and riveting it slightly on the block, through a mistaken notion of economy in the making, which may be true where there is a want of tool room facilities, but where a milling machine is within reach, the practice of making this class of punches solid or of one piece with the flange is the cheapest, as well as the best in every way in the long run. The punch is fastened to the holder *O* with screws and dowels *P Q*.

The next operation is the rounding of the corners on the outer side of the shuttle-carrier, as shown in Fig. 2, and is also done in a stamping press with the kind of punch and die shown in Figs. 8 and 9. The operation may be best designated as a squeezing, or squashing, operation; the bottom port, or the die, Fig. 8, is a tool-steel block hardened and ground straight and smooth on the surface. It is fastened with screws *U* to the holder, or shoe *S*. The shuttle-carrier blank, of the form shown in Fig. 1, is laid on the surface of the block *R*, between the spring gage pins *T*. The punch, Fig. 9, is of hardened tool steel, and has an impression *W* in its face *V*, the same form as the blank, Fig. 2; its depth is equal to the thickness of the blank when the punch fastened in the ram of the press comes down on the blank. Lying on the surface of the die it presses the gage pins inwardly, out of the way, and the round corners *c* in the depression in the face of the punch, strike, squeeze and round over the sharp corners of the blank, making it in the form of Fig. 2. The blanks are then "tumbled" for some time, to remove all sharp edges and to brighten them up. When taken out the two rivet holes *C C*, Fig. 4, are drilled in a jig, Fig. 10, and the hole *D* is punched in a small punching die, and tapped.

The two ends of the blank *A B* are then bent over in the bending punch and die, Figs. 11 and 12. It will be noted that the side of the bending block *X*, Fig. 11, is slightly tapering inwardly, in order that the end of the blank bent over that side may, when taken out, remain at right angles, which would not be the case if the side of the block was made square, as the material bent always springs back more or less. The block *W* is of tool steel, hardened and fastened with screw *Z* in the shoe *Y*. The faces *a* of the bending punch, Fig. 12, are hardened and ground out to the thickness of the bending block, plus two thicknesses of the metal of the blank; its operation is obvious from the illustrations. After the blank is operated on in this tool, it is of the form shown in Fig. 3.

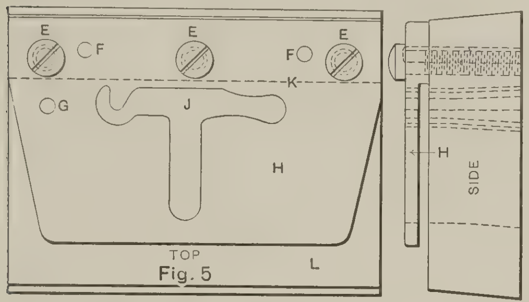


Fig. 5

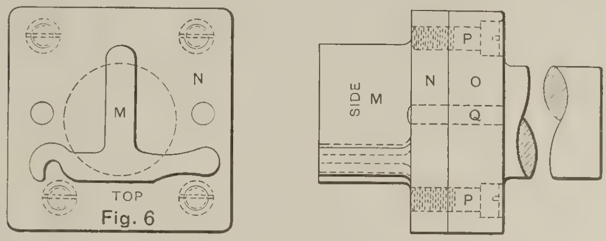


Fig. 6

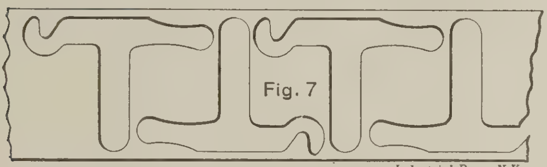


Fig. 7

Industrial Press, N.Y.

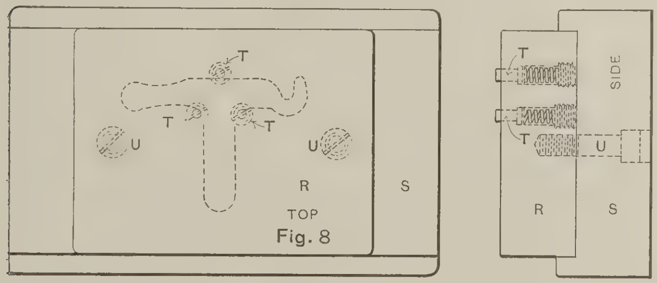


Fig. 8

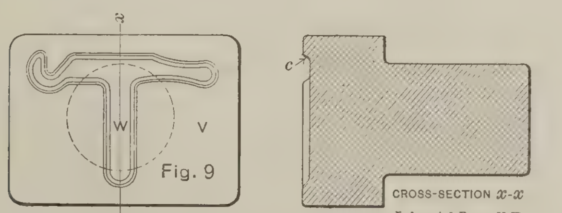


Fig. 9

Industrial Press, N.Y.

We now come to the last operation on the blank, that of forming the second bend on the side *B* of the point *E*, as shown in Fig. 4, which has to be brought to an exact position, without in doing so distorting the shape and form of the rest of the body. And while it is done in an ordinary stamping press, having the requisite stroke, the forming tools, which are in the form of a punch and die, are of a peculiar design and make, as will be noted from illustrations, Figs. 13 and 14. Like a good many other tools that, when made, are of simple manipulation, it may not impress the superficial observer. The difficulty is the original conception and determination of its shape and form, to meet in an inexpensive and simple manner the requirements for the successful performing of its operations. In Fig. 13, the base plate A_1 is cast iron. Fastened to it with the screws and dowels B_1 C_1 is a tool steel block D_1, through which there is a perpendicular hole E_1; on the side near the bottom there is a square hole F_1 leading into the opening E_1; two "jaws," or lugs, G_1; a depression H_1 and cut out port M_1 on the top. The shuttle-carrier as shown, with dot and dash lines, lies up against the side of the block, its bent end *B* fitting in the depression H_1, with its point *E* overhanging in the opening E_1, while its other end *A* as in the opening F_1. The two jaws G_1 keep it from "tipping" when the point E_1 is getting bent by the punch, Fig. 14, which, it will be noted, has a longer end J_1 on one side, that enters the opening E_1, first, and when the punch port L_1 comes up against the point of the carrier *E* and bends it, it keeps it from getting away. The part of the punch marked K_1 flattens and sets the side of the carrier, after the point *E* is bent over; when that is done the punch goes up. To take the completed shuttle-carrier out, it is necessary to raise it up slightly to move it forward out of the jaws G_1 when the top of the carrier gets in the middle of the recess M_1, it is taken out completed, as shown in Fig. 4.

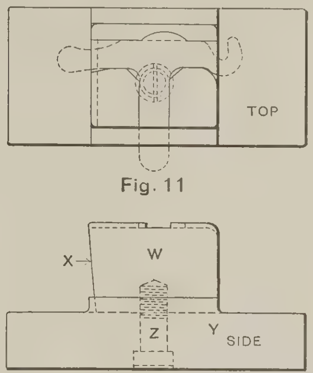


Fig. 11

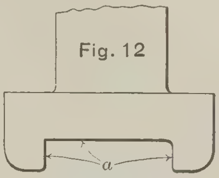


Fig. 12

Industrial Press, N.Y.

* * *

OUR BATTLESHIPS.

A rather startling statement was made in Congress by Senator Hale, of Maine, in discussing the naval appropriation bill, that the battleships Indiana, Massachusetts, Oregon and Texas should not be counted as ships of the main line of defence after the year 1908. This means, of course, that they will be looked upon as practically obsolete by that time. This raises the question as to the active life of our modern $5,000,000 and $8,000,000 battleships. Judging by the Oregon, which most people believe to be a crack ship of the navy even now, a battleship will become obsolete within twelve years. The reason for such a condition has been mainly because of the contest between armor and armament, resulting in the rapid and very great improvement of each, so that a ship of ten or twelve years ago would stand no chance against one equipped as a vessel would be fitted out to-day. The next step, however (which may result in all the battleships of the present era becoming obsolete) will undoubtedly be the substitution of high-power turbines for the more cumbersome reciprocating marine engines, in which case the battleships of the future would be able to steam over a much greater radius and, in cases of emergency, at much greater speed than heretofore. In other words, they will, in all probability, be able to go further and either run away from, or overtake the enemy, provided the enemy is aboard an old-style ship driven by reciprocating engines.

That there is a strong movement toward this end is evidenced by the announcement of the Westinghouse Machine Co. that they are to manufacture marine turbines for vessels of large size, and by the investigations now being conducted by the naval authorities, with a view to introducing the turbine.

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Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MAY, 1904.

NET CIRCULATION FOR APRIL, 1904,—24,926 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

One of our contributors has written us criticising the use of the word "standard" in connection with one of the data sheet tables issued with the *Engineering Edition.* He contends that while this sheet may have been a standard in the shop where it was developed it is in no sense a national standard, and that the term is therefore wrongly applied and might be misleading. Our contributor is right. The word has a broader signification than is applied to it, and is often used in too narrow a sense. We have in preparation, however, several data sheets to which the term "standard" can be applied without serious criticism. These sheets are to be made up from the tables that have been developed by the engineering staff of the Navy department and the Bureau of Steam Engineering for the use of draftsmen in those departments. We shall select the tables that will be of greatest value to the average designer or draftsman, and we believe they will be much appreciated by the many subscribers to the *Engineering Edition.* The data sheet this month contains as its leading feature what is probably the most complete tap-drill table for V-threads that has ever been published. It gives the sizes of drills varying by fractions of inches up to 2 inches in diameter, as well as machine screw sizes; and the point that will make the table of unusual value is that instead of denoting theoretical tap drill sizes the practical sizes are given—which are slightly larger than the calculated diameters. In other words, the table is a complete workable table for shop use.

* * *

ARE WE EAGER TO LEARN?

A paper read before the Institution of Electrical Engineers gives a transatlantic view of American engineering education. The author, Dr. R. M. Walmsley spent three months last year in investigating our engineering schools, and succeeded in gathering a great amount of practical information which was of a flattering nature as a whole, especially in comparison with British conditions. Not only is the character of the engineering instruction upon the whole higher here than abroad, but the discrepancy in the number of students is startling. Dr. Walmsley found in sixteen of our prominent institutions 1,371 students in engineering courses who had been more than three years in attendance, while the latest available report in Great Britain showed but 56 students in the corresponding class. This difference does not so much indicate lack of facilities as difference in aims. Among first year and second year students, the comparison is upon more even terms, the truth being that with some distinguished exceptions the British technological schools are substantially what we would know here as trade schools, from which the pupils frequently pass into their technical pursuits without waiting to complete the course.—*Electrical World and Engineer.*

The foregoing note presents an interesting point in regard to the development of engineering education in America. This can be better appreciated when it is remembered that the development has come within the short period of 40 years. Forty years ago there were scarcely half a dozen institutions, outside of West Point and Annapolis, where students could obtain advanced instruction in civil engineering, while electrical engineering was, of course, unknown, and mechanical and mining engineering were scarcely thought of as subjects for study. But in 1862 there was passed the Land Grant Act, through the able efforts and keen foresight of the late Senator Morrill, of Vermont, which provided for the proceeds of the sales of public lands to go as a perpetual fund for the support of State colleges, where agricultural and mechanic arts were to be taught in connection with other studies. The object of the bill was to give an opportunity to those engaged in industrial pursuits to obtain some knowledge of the practical sciences and the mechanic arts which could then not be obtained at the classical colleges. The act gave a wonderful impetus to engineering education in America and is primarily the cause of the founding of many institutions not receiving government aid. It has led to the establishment of over one hundred technical colleges, and while these are small compared with the great German universities, and the total attendance is probably much less, engineering education is advancing by leaps and bounds in America, and according to Dr. Walmsley our students are more eager for advanced instruction than their English cousins, even if they are not yet on a par with German students.

* * *

SUPPRESSED DATA.

An important part of a liberal education, is learning "what not to do." There is a straight and narrow path which, followed, will lead to a certain desired goal, but until that path has been blazed through the wilderness of ignorance there is little guidance. It may be that after one way is found that numerous parallel paths leading to the same result will be discovered—usually by deduction which points them out when one set of facts has been conclusively demonstrated. But, while original research means numberless experiments and trials that give negative results, these results may be negative only as affects a certain desired end, and they might be valuable along another line of investigation. It, therefore, seems a pity that so much original work is lost to the world simply because it has not yielded the ends that the investigators desired.

Every large concern that has a testing department is constantly accumulating the experience of tests that, so far as the world at large is concerned, is lost. The world is only benefited in the concrete results of such tests as may appear in the shape of machines, processes or apparatuses. The negative facts are never known when very often, if they could be published, they would be of considerable value to the engineering world. But in making public negative results it would often be necessary to show the methods employed and that would amount to a disclosure of the general laboratory practice. Of course any firm or corporation is in general naturally violently opposed to the publication of their researches, as often about all that they have to show for it is that the "other fellow" will have to spend an equal amount of money to find out that something is not so. Those experiments that have proved successful are regarded as valuable assets. Mr. Morcom, an associate of the British Institution of Electrical Engineers, referred to the great mass of buried data that is in existence and expressed regret that such a condition existed, but it seems largely unavoidable. It is only when a firm is broad in its views that original work of this character is occasionally permitted to be made the subject of a paper to be read before some engineering society. Mr. Morcom suggested no remedy, and perhaps there is none.

CUNARD COMPANY LEADS OFF.

The Cunard Company has taken the initiative in the matter of turbine equipment for fast transatlantic vessels by deciding to install turbines aggregating 75,000 horse power for each of two immense vessels that are about to be built. These vessels eclipse the *Kaiser Wilhelm II* in size and displacement, and it is expected they will develop a speed of 25 knots an hour and make the trip across the Atlantic in five days. The decision to use turbines in place of reciprocating engines came as the result of an extended investigation by a commission of experts made up of some of the most distinguished engineers of England and in spite of the fact that their report was not by any means altogether favorable to the turbine. It is believed that the turbines will weigh nearly as much as reciprocating engines of the same speed, that they will consume nearly as much steam, and that what little is saved in weight will be balanced by the larger auxiliary machinery required—such as larger condensers and air pumps, etc.—to take care of the much greater volume occupied by the steam at the high vacuum required for the economical operation of the turbines. It is held, however, that the smooth action of the turbines and the ease with which they can be cared for are sufficient arguments for their adoption.

Each of these Cunarders is to be fitted with four shafts. The two outer ones will be driven by high-pressure turbines and the two inner ones by low-pressure turbines. The inner ones will also be fitted with separate turbines for backward motion. It is not stated what type of turbine will be used, but presumably the Parsons, as this has been developed to the greatest extent in England, where the vessels will be built. We believe this type of turbine will give eminently satisfactory results, as the principles of operation of a large turbine are not to any extent different from those of a small machine. It is probable, however, that the weight of the Parsons turbine will be somewhat greater than that of some other turbines, because of the large number of rings of blades required in this type to completely expand the steam.

* * *

NOTES AND COMMENT.

A very peculiar and distressing accident by which a diver lost his life, occurred April 11 at the Rockaway River reservoir, near Boonton, N. J. The stem of one of the 50-inch valves in the outlet pipes was accidently twisted off with the valve about half open, and in order to make the necessary repairs a diver had to descend through the penstock. But this was a hazardous undertaking with the valve in a half-open position on account of the suction of the flowing water, so an attempt was made to shut off the flow of water by sinking a nine-foot wooden ball weighted with lead, over the inner opening of the pipe. It was expected that the ball would act as a check valve, as the pressure due to about a seventy foot head would hold it firmly against the opening. But in sinking the ball it did not lodge squarely over the opening so Hoar, the diver, descended in his suit to shift the ball into position. In some manner unknown he was caught between the ball and the end of the pipe, and there held for nearly four days despite extraordinary efforts to free him. At last another diver descended into the penstock and repaired the valve so that it could be closed, and only then was it possible to release the body.

The T-section is so universally used for rails that it is a novelty to consider any other form or to think that any other practical shape might have any advantage. However, a German rail section is being introduced in the United States which is of inverted V shape, the inner and outer lines being parallel so that the same pair of rolls may be used for rolling rails of different weights. Moreover, the face of the rail is rolled harder than is possible with the T-section. It is claimed that this rail has six times the lateral strength and one-half more vertical strength than the present T-section rail of equal weight. With this rail no splice bars or bolts are used at the joints, the connection being made simply by using a short section of the same weight of rail placed underneath and within the V's of the track rails, so as to bridge the joint. By the use of wood blocks fitted in the V between the rail and the tie, a large elastic bearing is secured. The rail is held to the ties by spikes the same as the T-rail now in use. Should this rail be used it will seemingly require a considerable modification of the present forms of switches.

The life of a miner is dangerous at best, and it would seem that safety devices for lessening or preventing accidents should be used wherever possible, but the introduction of the simplest appliances of this order seems very difficult. One of the ever-present dangers in cage hoisting is that of over-winding, that is, of not stopping the hoisting engine when the cage has reached the surface, the result being that the rope is broken and the cage hurled to the bottom of the shaft with its human burden. Two shocking accidents of this character have occurred in the United States within a few months, the men in one case falling a distance of 1,500 feet to their death. Now there are several safety devices of well-known efficiency for preventing just such accidents, known as "safety-hooks." The safety-hook connects the hoisting cable to the cage, and in case of over-winding the hook detaches from the cable, letting the latter whip around the drum without damage, and at the same time it locks the car to an overhead support, thus preventing its falling back into the shaft. When it is considered that hoisting engines operating deep shafts are run at high speed, it must be admitted that the danger of over-winding is great, and the wonder is that more such accidents do not occur. But to secure the general adoption of the safety-hook it will doubtless be necessary for all States to adopt compulsory laws for that purpose.

An engineer (Mr. Edwin Reynolds) was asked some years ago to visit a copper mine in northern Michigan and design some ore-crushing stamps. He accordingly went to the mines, where, for the first time in his life, he saw stamps at work. He found them reared on a huge foundation of spring timbers and rubber sheeting, which was supposed to add to the efficiency of the stamps. His simple comment was "If I were trying to crush rock I would not start to do it on a feather bed." He suggested that the spring timbers be replaced by a solid mass of iron, so that the blow of a stamp should wholly expend itself in crushing rock, and not largely in compressing an immense elastic mass with utter waste of power. Only at the end of two years did the (Allis) company permit him to build such a stamp. It did just sixty per cent. more work than the old machinery. During forty years elastic cushions under every mining stamp in the world had been wasting almost one-half of the applied energy.—*World's Work.*

[The foundations of steam and drop-hammers have also suffered a similar change, the "feather bed" theory having been proven fallacious, but formerly such foundations were thought necessary to prevent breaking the dies and anvil blocks.—EDITOR.]

TEN YEARS TO GET RID OF THE ERRORS.

"In 1895 I published a mechanical engineer's pocketbook, of which more than 30,000 copies have been sold. The collection of the material for this pocketbook took more or less of my time for twenty years, and the making of the book not less than three years' full time. The things compiled in it involve reference to engineering works, papers and periodicals, some of them dating back at least 60 years. There are 1,100 pages in the book, and each page has about 900 words. The number of figures and formulæ in the book, which are based on the English inch, run into more thousands than I would care to figure. The task of getting such a book free from errors is a tremendous one. Over a thousand typographical and other errors have been reported in the last eight years. Mr. John C. Trautwine, Jr., told me some twenty years after his father's civil engineers' pocket was first published that he was only then beginning to feel that the book was reasonably free from errors. If my book were translated into the metric system, it would be at least ten years before all the errors in the translation would be rectified. I doubt if the translation could be made without at least five years' hard labor of an expert mathematician."—*William Kent, before the House Coinage Committee of Congress.*

* * *

OBITUARY.

Frank B. Kempsmith, formerly of the Kempsmith Mfg. Co., but for some time past retired from active business, died at his home in Milwaukee, April 10, aged 55 years. Mr. Kempsmith enjoyed a reputation in the machine tool field as a skillful mechanic and man of great ability. He was the originator and designer of the Kempsmith milling machine manufactured by the above-named company. Mr. Kempsmith was employed at different times and in different capacities by the Brown & Sharpe Mfg. Co., the Garvin Machine Co., and was also superintendent of the shops of Warner & Swasey, Cleveland.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A striking figure typifying the iron industry of the South, especially of Birmingham, Ala., is that of Vulcan, which will form part of that state's exhibit at the Louisiana Purchase Exposition at St. Louis this year. The statue was modeled in plaster in Passaic, N. J., by the sculptor Moretti and was shipped to Birmingham, where the castings were made. The figure is cast in 15 parts, the total weight of which is something like 100,000 pounds, and stands 56 feet high.

CANADIAN PATENT LAW.

A recent consular report quotes an abstract of the Canadian patent law, which indicates that such patents become null and void unless the invention shall be continuously manufactured within the borders of Canada within two years from the date of granting the patent. The courts, however, have modified this clause so that if an inventor stands ready to supply a demand for his invention, that is, to build to order, it is held to satisfy the letter of the law. Another clause provides that the patent shall be forfeited if the invention is imported into Canada by the inventor or his legal representatives after the expiration of one year from the granting of the patent. From the foregoing it appears that the average Canadian patentee stands a much better show of losing his patent than he does of holding it.

Where it is difficult to obtain pulleys of exact relative sizes for synchronous operation of generators, or other purposes, the diameter can quite easily be increased one-half inch by means of a paper covering. To do this the pulley—no matter what material it is made of—should be thoroughly cleaned of all grease and oil and the surface roughed up by scraping or draw filing. Heavy manila paper cut to the right width is glued onto this surface, being careful to have the glue hot and not too thick. Press the paper firmly down on to the pulley face in starting and then draw the paper tight as the pulley is turned, pressing and pounding the surface carefully as each additional section is glued. When one complete cover is fastened to the face of the pulley the glue is applied to the exposed surface of the paper and the operation continued, being careful to see that no bubbles or wrinkles are left on the surface. If it is desired to make a crown on the pulley, this can be done by gradually narrowing down the width of the sheets which are being glued. This glued paper addition to the pulley forms a substantial, lasting surface and makes a very good surface for the belt to drive upon.—*Western Electrician.*

The manufacturer or exporter who would succeed in placing his wares in foreign markets, must carefully study the habits and customs of the people with whom he desires to deal. Not the least important consideration are the laws governing partnerships, contracts, etc. Judge Tourgee, the U. S. Consul at Bordeaux, France, says that a contract of partnership or for the purchase of realty or the sale of realty, or a contract of indemnity, is void and will not be recognized by the French courts unless drawn and executed by a notary public and it must be in the French language. A contract written in English, though attested by a notary public, is void. The Consul advises that the first thing for an American to do who seeks to introduce a business of any sort into France, whether by partnership, agency, or otherwise, should be to employ a competent legal adviser and consult him fully on all his affairs, not because those with whom he deals are any less reliable than other people, nor because the laws are less equitable in character, but because it is no easy matter to become as familiar with their application as with the common law, which is the basis of our business thought. It will not do to assume that the legal principles which govern and control business relations and responsibilities under our laws have any sanction except in Anglo-Saxon countries. Very many of the losses sustained by American exporters in their endeavor to find a market for their goods in France are traceable to their entire neglect to consider the legal conditions under which they must operate.

BOILER MATERIAL AND BOILER CORROSION.

Stahl und Eisen, January 15, 1904, p. 82.

In an article on the above named subject the writer details some of the observations and investigations made by Engineer Diegel of the German navy. According to these observations, which were made in connection with a large number of plates, it has been found that

1. Of two plates in service in metallic contact with each other, and having different contents of phosphorus, sea water will corrode the one holding the higher percentage of phosphorus less than it will the one with the lower percentage. 2. Every indication is to the effect that two kinds of iron or steel when submerged in sea water form a galvanic cell, in which the metal that is rich in phosphorus is the cathode and will be more or less protected, while the one that is low in phosphorus becomes the anode and is rapidly corroded. 3. The iron that is low in phosphorus will corrode the more rapidly as its exposed surface is small in proportion to that of the metal having the higher percentage of phosphorus.

Diegel also made a large number of experiments with double plates suspended in iron vessels filled with fresh sea water. He found that the corrosion in sea water taken from open harbors was nearly twice as great as in that from the open, although it was frequently renewed. In these receptacles Diegel also tested unsubmerged double plates, made of different qualities of metals, and also some half submerged in sea water, the upper portion being sprinkled with the same every day. These experiments gave the following results:

In the case of the half submerged plates that were separated from each other, the influence of the phosphorus is still evident, even though it is not very great. As the content of phosphorus increases the corrosion decreases.

In contradiction to the experiments of Diegel are those of Chief Engineer H. Otto, who exposed test specimens of different kinds of metal to the atmosphere, to warm damp air, to warm feed water, to service in a boiler, and to artificial sea water, and found that the different percentages of contained phosphorus had no marked influence upon the rapidity of the corrosion of the metal.

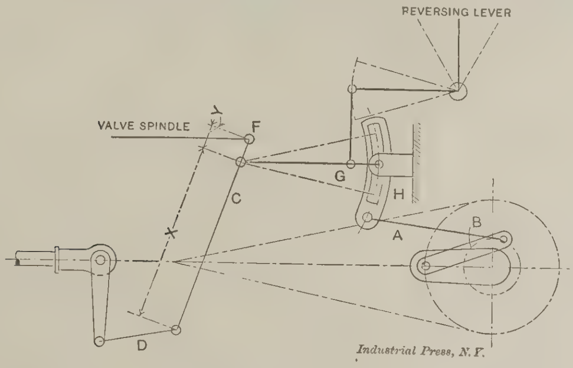
Diegel acknowledges that his results obtained in sea water need to be verified by tests in boiler service, but, at the same time, he is very confident that the rate of corrosion between iron plates, poor and rich in phosphorus, will be thoroughly established, and that if a small iron plate containing less than .01 per cent. of phosphorus be used in a boiler with iron containing about .09 per cent. of phosphorus, it will be entirely eaten away in a short time. But boilers are not fed with sea water, so that Diegel's results do not have a direct bearing on boiler corrosion except to point out a general tendency. He, however, insists most strenuously that, in order to secure the greatest freedom from corrosion, it is advisable to use steel made from the same heat or at least that having the same phosphorus content. The author does not consider that Diegel has presented data enough to prove his point, but, at the same time acknowledges that the matter is worthy and should be made the subject of, further investigations.—G. L. F.

ANALYSIS OF THE WALSCHAERT VALVE GEAR.

Mechanical Engineer, April 1, 1904, p. 162.

The valve gear known as "Walschaert's" is extensively used on European locomotives. It probably owes its success to the arrangement of the levers, etc., which permit of the steam chests of the cylinders being placed above instead of on the side, a result which is not obtained by the Stephenson, Gooch, or Allan link motions without the use of rocking levers or other complications. This consideration, together with the space saved on the main axles by the absence of eccentrics, is an important advantage in large locomotives, or for locomotives of very narrow gage. Its advocates also claim that inasmuch as the gear is exposed to view and easily accessible, it is more likely to receive proper lubrication and adjustment than those gears which lie between the frames and under the boiler. It must be admitted, however, that this claim has but little weight.

The accompanying illustration shows the gear in outline only, but it is sufficient for the purpose of analyzing the action of the various levers. The rod A, which actuates the link is driven by a return crank B, the center or crankpin of B being at such an angle to the main crank that when the latter is on the dead center the link H will be in its central position. Neglecting for the present the effect of the levers C and D, it will be seen that the arrangement would form a suitable reversing gear for operating a valve without lap and lead, always provided that the reversing handle be placed in full gear either forward or backward. Now whatever the amount of lap and lead given to the valve, they must be accounted for by the lever C, which derives its chief motion from the crosshead through the medium of the link D. As to the valve itself, it may be designed in exactly the same manner as a valve driven by an eccentric, the lap, travel, etc., being found by Zeuner circles. Having determined the lap and lead, we set out the position of the link when the main crank is on the dead center. The pin of the return or valve crank B will then be at half stroke. Meanwhile the crosshead will be at the extreme limit of its stroke, and therefore the lever C must throw over the center F by an amount equal to the lap plus the lead; hence the lengths of the two arms of the lever C must bear the same proportion to each other as the lap plus lead bears to the length of the crosshead movement. When the pin A is at extreme position, either front or back, the crank is at half-stroke, consequently the lever C will move the valve over somewhat more than is due to its motion from the return crank. This must be allowed for in the design. X and Y being the lengths of the long and short arms of the lever C, and T being the proper full travel of the valve, the motion received by the valve spindle from the pin of the return crank B must be less than the proper full valve travel by an amount equal to $\frac{T \times Y}{X}$.



Industrial Press, N.Y.

The Walschaert Gear.

To obtain the best results with this gear, the reversing link should be suspended at the center; the suspension rods should be as long as convenient, and the lifting levers should connect to the radius rod G as near the link block pin as possible. Attention to these points will reduce the slip to a minimum. On trying this gear round it will be found that, if properly designed, a constant lead is given for all positions of the reversing handle, but otherwise the steam distribution is practically identical with that of a Stephenson or Allan link motion.

PEAT AS FUEL IN GERMANY.

Consular Report No. 1925.

Raw peat as it comes from the bog in all but exceptionally high and dry locations contains usually 85 per cent. of water. Experience has shown that the remaining 15 per cent. of peat substance, if dried and burned as fuel, contains only heat units sufficient to evaporate 28 per cent., or one-third, of the 85 per cent. water which the crude material originally contained. This is the fatally weak point in all artificial peat-drying processes. They consume more heat units than they can produce. The essential point is to eliminate by drainage and air drying every possible atom of water. This is done by two methods, dependent somewhat upon the use for which the prepared peat is designed.

In all cases, however, good management includes as a first step the drainage of the bog by ditches, cut at intervals to a depth of about 18 inches below the bottom of the peat bed which it is designed to work. Into these at least 50 per cent. of the water settles and either flows off by gravity or is pumped out by the wind-driven pumps. The drained peat is then excavated, either in blocks, cut with an angle spade specially designed for the process, which are hauled away in hand cars and laid out on the ground to drain and dry by wind and sun, or by machines which by means of steel scoops or diggers running on an endless chain dig out the peat, carry it up to a sufficient height, and dump it into hand cars, which transport it to the machines, by which it is further treated and prepared.

A complete plant of this kind, which was exhibited in constant operation by Mr. C. Schlickeysen, of Rixdorf-Berlin, formed a prominent feature of the first exposition of the Association for the Promotion of Moor Culture held in Berlin this year. The excavating machine, which was driven by an electric motor, was mounted on a portable track of light rails, designed to be moved over the moor as the peat is exhausted by excavation. The machine digs out, elevates, and drops into the dump cars a ton of raw peat every five minutes. It is transported to the machine, conveniently located at the edge of the bog, which tears, pulverizes, kneads, and presses the plastic mass out into long masses or "strains." These are cut into sections a foot long and dried in the open air to hard, tough blocks, which resist rain and bear transportation to any distance. The secret of this part of the process seems to be that the crushing and grinding action of the machine releases the fluid organic elements of the raw peat, and these mix with the solid fibrous portion, forming a matrix or binder which when dry holds the whole mass firmly together. In drying, the strains shrink to about one-half their size when in a plastic state. If mixed while in a soft condition with 20 to 30 per cent. of anthracite or bituminous coal dust they form when dry an excellent fuel of high calorific value. Otherwise, they may be carbonized by heat into peat coal or coke.

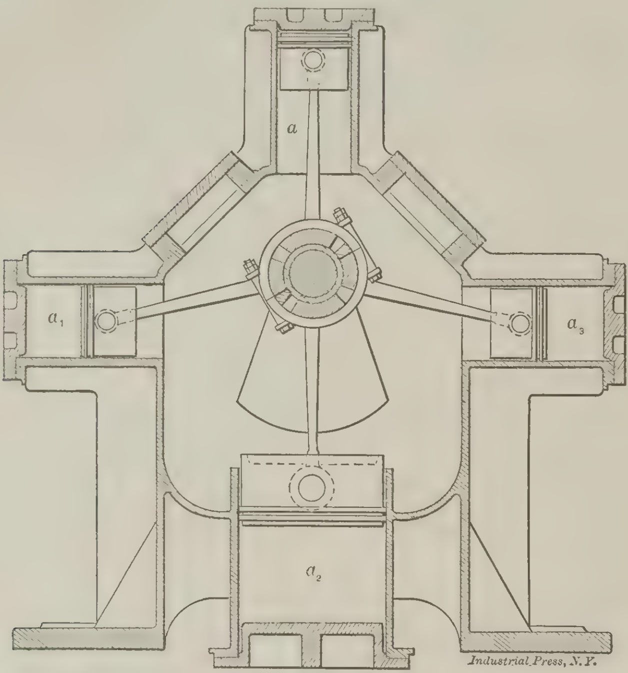
Both the latter are pure and free from sulphur or phosphorus, and are therefore valuable fuel for the finer processes of metallurgy, but they are inevitably too expensive to compete on a large scale with ordinary coal and coke. Any form of peat fuel, in fact, represents the recovery of a small percentage of crude vegetable matter from a large proportion of water and the preparation of this residue by processes which are inevitably so laborious and expensive that unless the most improved and economical methods are employed at every stage the cost exceeds the fuel value of the product.

Notwithstanding all difficulties, however, progress in the preparation and use of peat fuel is steady and constant, and Sweden, according to recent reports, has succeeded in utilizing it for locomotives. On the government railway from Elmhut to Malmo specially constructed freight locomotives have been fired during the past year either wholly with peat fuel or a mixture of the same with English coal, and the engineer's reports claim for the experiment both a mechanical and economic success.

MULTIPLE EXPANSION STEAM ENGINE.

Der Practische Maschinen Konstrukteur, January 21, 1904, p. 10.

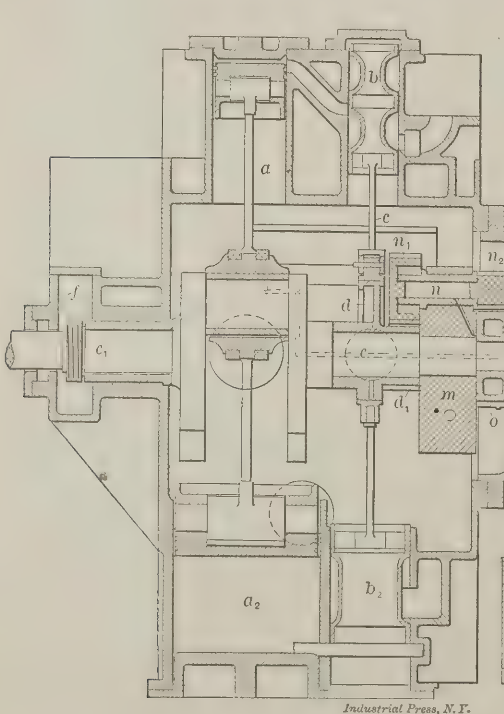
Fryer & Co., of Rouen, France, have recently brought out an interesting four-cylinder multiple expansion steam engine whose general scheme of construction is shown in the section Fig. 1; Fig. 2 also shows a stationary engine; and Fig. 3, one that is reversible. The engine is also made in a form adapted to automobiles. Under each of these conditions four cylinders are used and they are arranged in the form of a cross with the connecting rods of each taking hold of one and the same crank pin. Of the four cylinders, three are of the same diameter while the fourth cylinder has twice the diameter of the others, and so serves as the low-pressure cylinder. The steam distribution for all four of these cylinders is effected by means of piston valves driven from a single eccentric. It depends upon whether the engine is built as a stationary or reversible engine as to what modifications shall be made in the movement and attachments of the eccentrics. In the first case there is a direct connection by means of the usual eccentric rod, but in the second some extra parts are introduced, as in Fig. 3.



Industrial Press, N.Y.

Fig. 1. Cross-section of Multiple Expansion Steam Engine.

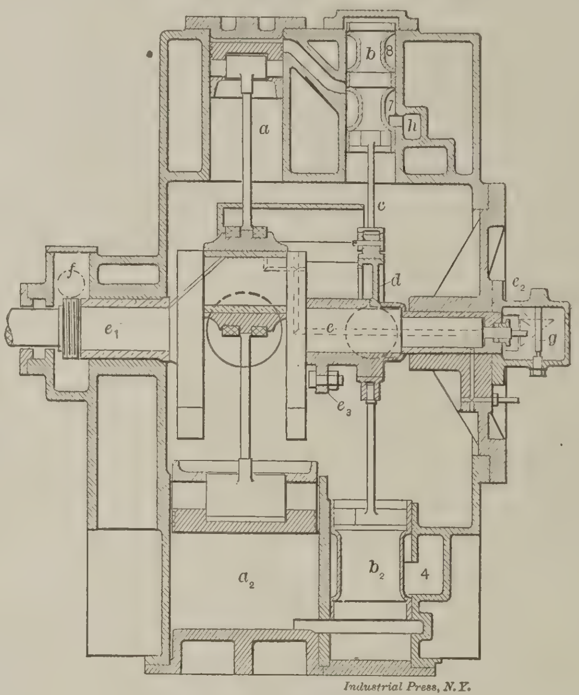
The regulation to varying loads is taken care of by the adjustment of the distributing valve k, shown in Figs. 4 and 5. Here the shaft of the handwheel carries a pinion that meshes with a rack attached to the back of the valve by which the latter may be moved to and fro. In this way it may be set in any one of the positions corresponding to as many variations of power development by the machine. This distributing valve is about the size of the piston valve and is fitted with two D's of unequal size by means of which the group of ports 1, 2, 3, and 4, 5, 6 can be put into communication with each other. The attendant is thus in a position to admit steam into one or into all three of the high-pressure cylinders, and thus change the power development of the engine at will, it being the least in the first instance and greatest in the last.



Industrial Press, N.Y.

Fig. 3. Reversing Engine.

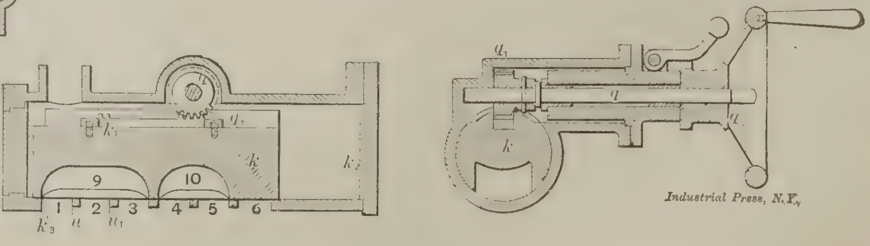
When working at its lowest power and highest efficiency the steam enters the valve chest k_2 from the boiler which is in communication with the passage h, Fig. 2, by another cast in the work. This passage h is cut off from the cylinder a by the piston valve b. The steam then has free access to the cylinder through the valve b, where it does its work, and is exhausted through the cavity 8 in the piston valve b and thence passes through the port 3 into the D cavity of the valve k. From here it issues through the ports 1 and 2 into the other two small cylinders a_1 and a_3 which, in this case, act as intermediate cylinders as long as the distributing valve directs the steam movement in this way. From the cylinder a_1, the exhaust steam flows through a passage cast in the casing to the port 4, which is in communication with the steam chest of the low-pressure cylinder a_2. This exhaust, then, does not pass through the distributing valve k at all, while the exhaust from the cylinder a_3 is also discharged through the distributing valve into the port 4. Finally the exhaust from the large cylinder a_2 is discharged through the interior of its piston valve into the casing of the engine whence it escapes into the air or is led off to the condenser. From what has been said it will appear that, in order to effect the greatest economy, the engine works as in triple expansion when developing the lowest amount of power.



Industrial Press, N.Y.

Fig. 2. Longitudinal Section.

If, now, the distributing valve k is so adjusted that the lip k_3 is over the bridge u, the first combination for the working of the engine as a compound is obtained. The live steam is no longer admitted to the cylinder a alone, but also to a_1 through the passage that has now been opened. When it has done its work in these two cylinders, a part of it is exhausted into the third small cylinder a_3 while the balance goes to the large cylinder a_2. It thus passes into the space 9 of the distributing valve which has now put the exhaust port 3 in connection with the port 2 and 4. As already stated the large cylinder still remains connected with the exhaust pass-



Industrial Press, N.Y.

Figs. 4 and 5. Longitudinal and Cross-section of Reversing Valve.

age of the cylinder a_1. The power developed is now greater than it was before, but the economy is less.

When the distributing valve k is moved so that its lip k_3 is over the bridge u_1, the second combination for compound action is obtained, and the engine will then be developing its highest power. Live steam is then admitted to all three of the small cylinders, a, a_1, a_3, at the same time, without giving the distributing valve k, any influence whatever over the steam admitted to the first cylinder a. The other two cylinders, a_1 and a_3, now take steam through the ports 1 and 2. After having done its work in the three small cylinders the steam is exhausted into the large cylinder a_2. In the case of the cylinder a_1, this is accomplished by connecting the ports 3 and 5 through the cavity 9 of the distributing valve. In this case the port 6 and the cavity 10 serve as an auxiliary exhaust.

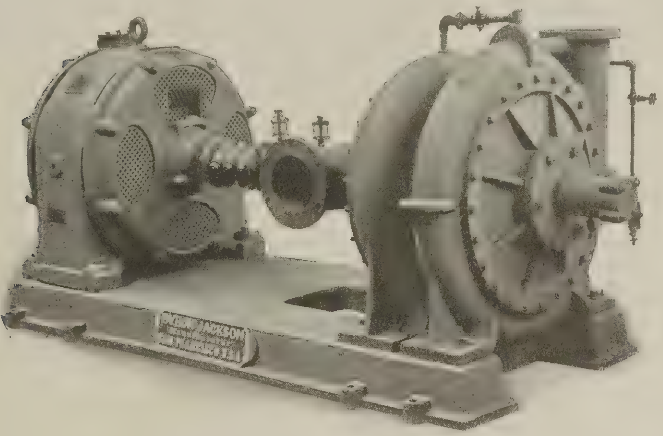


Fig. 1. Horizontal Multi-stage Turbine Pump.

According to the foregoing description the distributing valve makes it possible to run the engine under three different conditions of power development. The first of these is in triple expansion in which two of the small cylinders act as the intermediate, and there is a single one acting as the high pressure. The second is as a compound with two small cylinders working as high pressure and one small and the large working low-pressure. The third is where all three of the small cylinders work high pressure and the large one alone serves as the low. G. L. F.

HIGH-PRESSURE MULTI-STAGE TURBINE PUMP.

Engineering News, March 7, 1904, p. 324.

To apply electric motors to the work of pumping, rotary or "centrifugal" forms of pump are almost essential. The objection to the conventional style of centrifugal pump for most classes of pumping service is its unsuitability for working against even moderately high pressure. Moreover, even at the most favorable pressure for a given pump of this kind, its efficiency is not very great, possibly 60 per cent. as a maximum, falling off rapidly as the pressure increases or diminishes.

High efficiency in centrifugal or rotary pumps need not primarily be considered a desideratum. Ability to pump against high heads, however, is absolutely essential to any great extension of the field of usefulness of the rotary pump. This fact lent great value and interest to the introduction of a type of pump developed in a scientific manner from the principles governing turbine construction. European engineers were the pioneers in this. Turbine pumps of excellent design, suited for very high heads and giving satisfactory efficiency, have been built in Europe for a number of years. More recently American pump builders have entered the same field. Some illustrations and data of the turbine pumps of one American maker, the Byron Jackson Machine Works, of San Francisco, Cal., are given in the following:

It is to be noted that centrifugal pumps of the ordinary kind have in some cases been adapted to heads higher than a single pump could serve, by coupling them in series, so that each pump worked against only a part of the total delivery head. Essentially the same thing must usually be done with turbine pumps, with the difference that in this case each separate pump or "stage" is able to pump against five to ten times the limiting head of the ordinary centrifugal pump. This difference is wholly due to careful design of the impeller blades and the addition of guide passages (like those in turbines) for the purpose of converting velocity into pressure with minimum eddy losses. The pumps shown and described in the following are multi-stage turbine pumps of this kind.

The operating elements of the Jackson pumps are rotating impellers containing spirally-curved water passages, and fixed guide passages between successive impellers. The water enters the passages of each impeller at the center and by the rotation is forced out to a collecting chamber surrounding the periphery of the impeller. The ducts which lead the water from here back to the center of the next impeller are suitably curved to act as guide passages, similar in action to the guide buckets of a turbine. The water then enters the next impeller in an axial direction, its rotary motion having been transformed by the guide passages into rectilinear motion.

Fig. 3, a drawing of a vertical pump section, shows the relative arrangement of impellers A and guide passages B. The pump shown has the suction entrance at the top; the discharge leaves the collecting chamber of the last (lowest) impeller in a tangential direction. The shaft rests in a thrust bearing at the top, and is further held by bearings formed in the successive sections of the case. At the bottom it is provided with a special balancing arrangement, described below. Each impeller, where it joins the guide passages of the preceding case section, is fitted into the case so as to form as tight a joint as possible without introducing any great frictional resistance to rotation. With the exception of the entrance opening, the external surface of the impeller is exposed to the delivery pressure, so that there is a resultant upward pressure on each impeller, equal to the area of its entrance multiplied by the difference between the entrance and discharge pressures of that stage. If all the impellers are alike, the total upward thrust is equal to the product of entrance area multiplied by the total head on the pump. The pumps are so proportioned that this upward thrust slightly exceeds the weight of the rotating portion, consisting of impellers and shaft. The excess of upward pressure, however, is relieved by the balancing device located at the lower end of the shaft, with the result that the rotating part is pre-

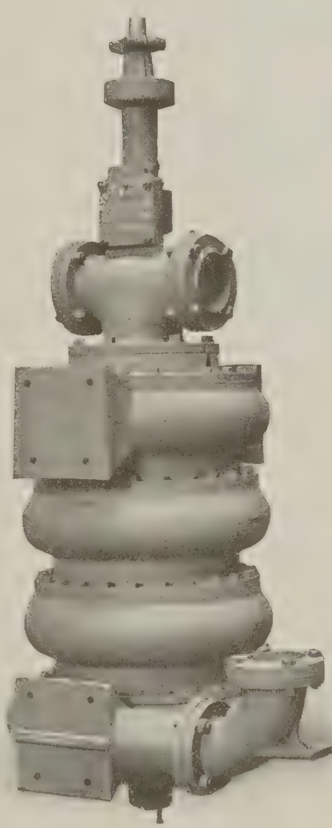


Fig. 2. Vertical Multi-stage Turbine Pump.

cisely balanced, thus relieving the thrust bearing of all load while the pump is running.

The balancing device referred to consists of two chambers, *C* and *D*, formed centrally in the bottom of the lowest section of the pump case. The large chamber *C*, incloses a projecting hub, *E*, on the lower surface of the impeller. This hub of course rotates with the impeller, and the joint between the hub and the walls of the chamber is, therefore, loose enough to allow water from the delivery side of the last impeller to leak into chamber *C* and establish the full discharge pressure in that chamber. The small lower chamber, *D*, contains a plug *H*, which may be adjusted endways by means of screws. The forward end of this plug fits closely into a recess in the face of the hub, *E*, which recess communicates, by way of the hollow central part of the hub and the passages *g*, with the entrance side of the last impeller. The action of the device is as follows: When chamber *C* becomes filled with water, or rather when leakage through the joint around the hub *E* has raised the pressure in the chamber *C* to the delivery pressure, the total upward pressure on the impellers is greater than the total weight of the rotating part of the pump. The rotating element is therefore lifted until the recess in hub *E* is raised clear of the plug *H*. In this position the pressure in chamber *C* is relieved through the passages *g*, with the result that the rotating element again settles down over the adjusting plug *H*. As this action tends to recur, a position of equilibrium is established near the point where the plug just enters the recess in the hub *E*. The precise position of this point may be altered by the adjusting screws of the plug *H*, thereby adjusting the endwise position of the impellers in the casing. When the pump is not in operation, of course the upward pressure of the water does not act, and the weight of the rotating part must be carried by the thrust bearing.

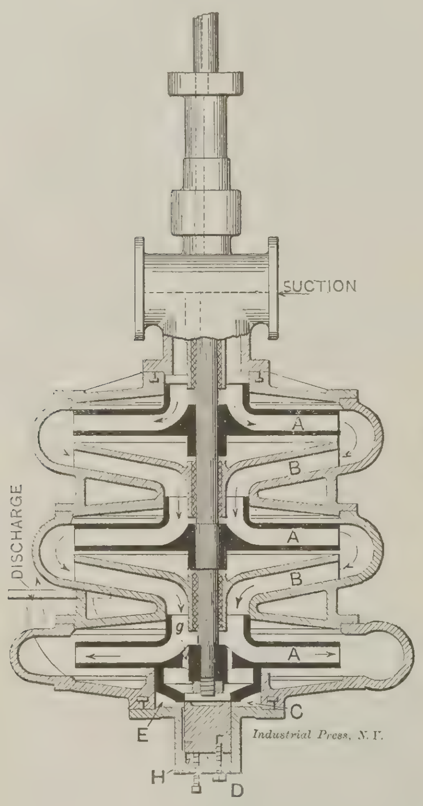


Fig. 3. Section of Vertical Multi-stage Turbine Pump.

When these pumps are built with horizontal shaft, the unbalanced pressure which is thus turned to account in the vertical pump becomes harmful and must be avoided. The arrangement by which this is accomplished is shown in Fig. 4, where the letters *A* and *B* designate respectively the impellers and the guide passages as before. The rear of each impeller—that is, the side opposite the entrance opening—bears a short annular projection, *S*, fitting within a similar ring *t*, projecting from the casing. The circular chamber formed by these two rings communicates, through holes, *V*, in the web of the impeller, with the entrance side of the impeller. The chamber being slightly larger than the entrance opening of the impeller, it serves to eliminate all thrust on the impeller in the direction of the suction (since the remainder of the external surface is exposed to the discharge pressure), and produces instead a small thrust directed toward the discharge end. This small resultant thrust is taken up by a balancing device at the end of the shaft precisely similar to that used in the vertical type of pump, as described above. The balancing action thus secured serves to fix the endwise position of the rotating part; moreover, it affords sufficient margin to compensate for longitudinal thrusts which may result from causes such as slightly non-central position of the impellers in their casing.

Pumps of this design are built for heads of from 100 to 2,000 feet, the number of separate impellers or "stages" being properly proportioned to the head. About 100 to 250 feet head per stage appears to be allowed. A high efficiency of working, from 70 to 80 per cent., is said to be realized.

GYROSCOPIC EFFECT OF FLYWHEELS ON BOARD SHIP.

Abstract of Paper read by Otto Schlik before the Institution of Naval Architects, March 24, 1904.

The author begins his paper by stating that ever since our forefathers began to navigate the seas, the tossing and rolling to and fro of vessels has been an unpleasant feature. It not only interferes with the physical welfare of the passengers and crew, but interferes with the proper performance of work, and detracts from the precision of gun fire in the case of naval vessels. He proposes to utilize the gyroscopic action of a revolving flywheel to dampen or reduce the rolling of vessels, and prefaces the description of the proposed apparatus with an elementary discussion of the principles of the common spinning top and the gyroscope:

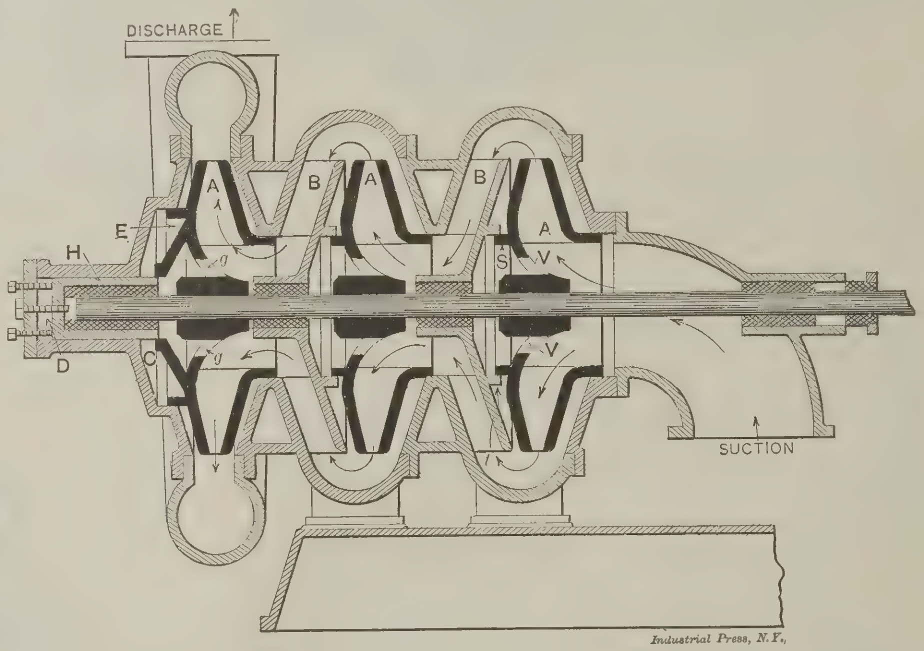


Fig. 4. Section of Horizontal Multi-stage Turbine Pump

Fig. 1 shows the front view, and Fig. 2 the side view of a flywheel *A*, which may be assumed to be revolving about a horizontal axis *a* in the direction indicated by the arrows. The axis *a* is borne in a ring *r r*, which can revolve in the journals *z z*, about an axis which is first assumed to be vertical. A particle of mass *m* on the circumference of the flywheel has for an instant a velocity in the vertical upward direction, and has, according to the law of inertia, the tendency to preserve both its speed and its direction of motion. It may be assumed that by the action on the system of an extraneous couple *M M′*, the ring *r r* is turned in its own plane through a certain angle, so that the axis *a a* of the flywheel becomes inclined, and takes the new position shown in Fig. 3.

While the particle *M* of the flywheel periphery in Fig. 1 is making for *n*, the inclination of the axis *a a* occurring simultaneously would compel it to go to *o*. But, since we have assumed that the ring *r r* can revolve in the journals *z z*, and consequently that the axis $a\,a$ also can turn in a plane that is at right angles to one in which the turning was first brought about by the couple $M\,M'$, it thus becomes possible for the point m (see Fig. 3) to reach n instead of o, the axis $a\,a$ turning the while in the plane lying at right angles to that of the diagram in Fig. 3. In this the end of the axis $a\,a$ marked N' will move toward the spectator, and the end N away from him, and the whole will assume a position such as is shown in perspective in Fig. 4.

A particle of mass lying on the back of the flywheel at the point furthest removed from m, is, as may readily be seen, subject to the action of exactly similar forces, which also tend in the same manner to produce a turning of the axis $a\,a$. If the flywheel, assumed in the position illustrated in Fig. 4, be viewed in the direction of the large arrow, it appears as illustrated in Fig. 5. The plane of the flywheel is caused to turn by a second couple $Q\,Q'$ or $N\,N'$, and is brought into the new position $x\,x$. In view of this, the direction of motion of a particle of mass q of the periphery will also be diverted, and instead of reaching q will be forced to move to s. By this another (third) couple $O\,O'$ is produced, in the same manner as was above illustrated, acting almost in direct opposition to the first one $M\,M'$, which produced the turning $r\,r'$ of the ring, and having the tendency to prevent the latter from turning. This third couple $O\,O'$ cannot come into existence if the inclination of the axis of the flywheel can take place only in one single plane. That is to say, if the ring $r\,r$ were not made capable of being turned about the journals $z\,z$, and the imparting to the flywheel of the deviation illustrated in Fig. 5 became impossible, no obstacle to the action of the original couple $M\,M'$ would present itself. The rapidly revolving flywheel would allow itself to be brought into the position illustrated in Fig. 3 with the same ease as if it were at rest.

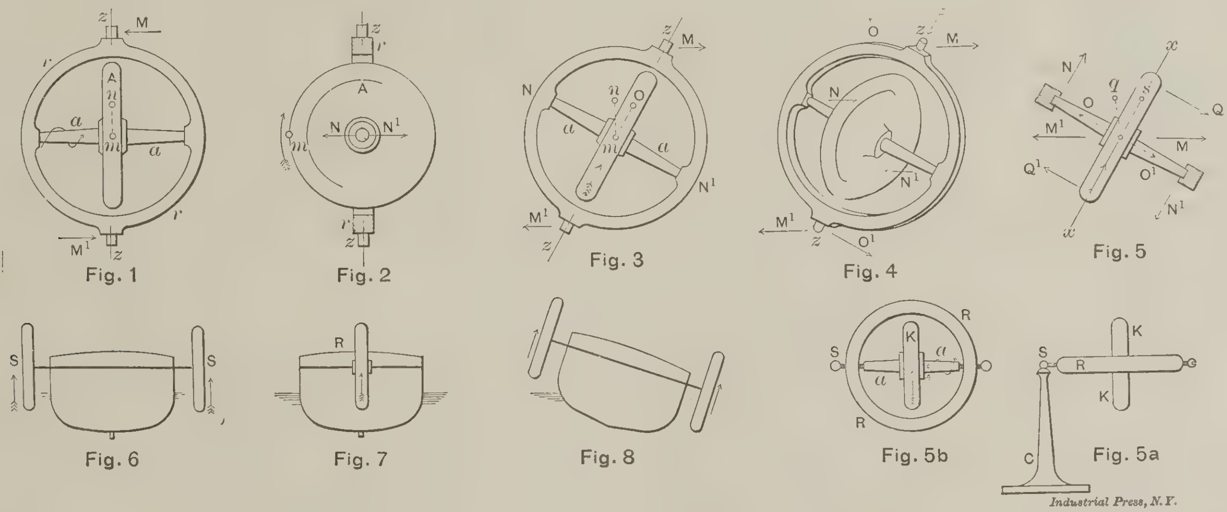


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5

Fig. 6 Fig. 7 Fig. 8 Fig. 5b Fig. 5a

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Illustrating Action of Gyroscope as Affecting Flywheels on Board Ship.

The above described properties of the gyroscope are familiar in a somewhat different form in connection with the well known toy known as the Archimedean top. The latter consists essentially of a small flywheel K, Figs. 5a and 5b, which is borne in journals in a ring R in such a manner that it can easily rotate about the axis $a\,a$. If the flywheel be made to rotate rapidly and the ring be supported at the point S by means of a ball-like projection resting in the cup-shaped head of a stand C, the ring does not respond to the influence of the force of gravity by falling from the stand, as it might be expected to do, but remains poised in the horizontal position, and turns slowly in the horizontal plane round the point S.

The same phenomena are here observable as were illustrated above. The force of gravity in the first place acts on the ring bearing the flywheel and resting on a support at one side, so as to try to move ring and flywheel downward, which action causes a turning of the axis in a vertical plane. This turning (or twisting) movement produced by the first couple in this case also brings a second couple into play, which produces the clearly observable rotation of the ring about the point S in the horizontal plane through the latter. This rotation in its turn brings the third couple into play, which neutralizes the first one resulting from the action of gravity, so that the weight of the ring with the flywheel apparently disappears altogether.

An ordinary paddle steamer possesses two wheels of equal weight, which, it is true, turn at a comparatively small velocity, but the influence of which must, according to what has been said, to some extent make itself felt. Their effect, so far as the conditions above illustrated come into play, is exactly the same as if two flywheels were hung one on each side of the vessel, having the same angular velocity and the same moments of inertia as the paddle wheels. The effect produced by these two flywheels $S\,S$, Fig. 6, would be in nowise altered if they were replaced by a single wheel R, Fig. 7, within the the vessel, having a moment of inertia equal to the sum of the moments of the two. The effect of these assumed flywheels is similar to that seen in Figs. 1 to 5. In Figs. 6 to 8 the cross section of the vessel is viewed from the stern. The effect of the wheels makes a paddle-wheel steamer behave materially different from a screw steamer in a sea way. When a paddle steamer heels to starboard, and the starboard wheel in consequence dips further into the water, a turning of the vessel ensues, not to port, as one would expect, but to starboard, and *vice versa*. In fact, the gyroscopic influence of the paddle wheels on the steering in part counterbalances the influence exerted by them on the water. Otherwise it would be still more difficult than it now is to keep a straight course with a paddle steamer in stormy weather.

The phenomena which present themselves in connection with an arrangement of this kind may best be studied by the help of a model, such as that illustrated in Fig. 9. This shows a pendulum which is able to swing to and fro on an axis at n. Above, the pendulum takes the form of a semicircular fork-piece B. A ring R is hung on the point of the screw pins $p\,p$, in such a manner that it can turn about a horizontal axis through the center of the fork-piece. In the ring itself, which is so weighted at the point S that, when inclined by any means, it will always return to the upright position, a vertical spindle a, carrying the flywheel F, is set in bearings. If the pendulum be set swinging without the flywheel being made to rotate, it will be found to move to and fro with a certain definite period. The frame in which the flywheel is borne may first be allowed to move as easily as possible—i. e., with a minimum of friction. If the flywheel be then set spinning and the pendulum receive a push, the latter will, in the first place, show a considerably increased period of swing.

The flywheel oscillates with its frame during the swings of the pendulum with a so-called phase difference of 90 degrees—that is to say, the swings of the axis of the flywheel keep lagging behind those of the pendulum by a quarter of a swing. While the pendulum is passing its central (vertical) position, the axis of the flywheel will show its greatest inclination; and when the pendulum is in the outermost position of its swing, the axis of the flywheel stands exactly in its middle position. The amplitude, or extent of the swing, of the pendulum will, as theory tells us, not be influenced thereby, but will remain exactly as great as before. That this is the case will also be readily apparent, since no consumption of energy takes place in the apparatus, the period only being influenced by the increase which takes place in the swinging mass.

Were it possible to fit a flywheel of this kind, able to swing in its frame without experiencing friction, into a vessel, this would be advantageous in so far that, to begin with, the rolling motions would become slower, and therefore less unpleasant; and then, on account of the great difference thus produced between their period and that of the waves, they would cease to be of any consequence. The rolling motions of the vessel would then become considerably less in extent. If the frame which bears the flywheel be screwed tight on the model, so that it can no longer turn, the effect hitherto produced by it will cease, and the pendulum will swing with the same period as it would if the flywheel were not rotating.

It will readily be seen that the effect produced upon the swings of the pendulum by the rotating flywheel can be of greater extent only so long as the plane of the frame bearing the flywheel remains approximately vertical.

If the axis of the flywheel be inclined at an angle *a* to the vertical, the moment thus produced, acting against the motion of the pendulum, will be proportional to the value of cos. *a*. Should the axis of the flywheel momentarily become horizontal, a position which with a pendulum in violent motion it may almost reach—that is to say, should *a* equal 90 degrees and cos. *a* equal 0—the influence of the flywheel will disappear altogether.

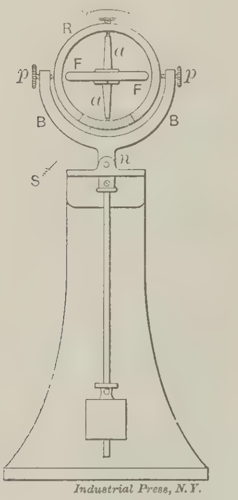

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Fig. 9.

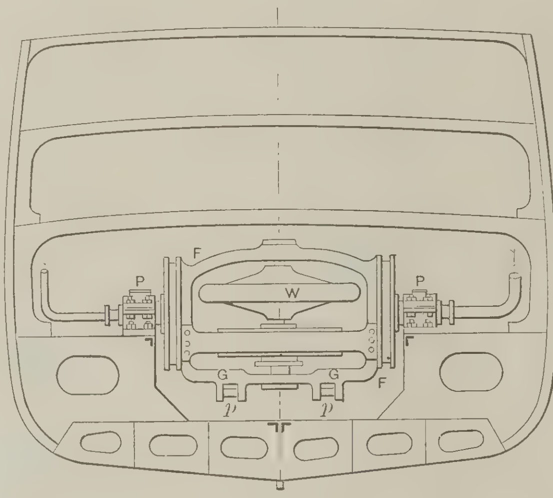

Fig. 10.

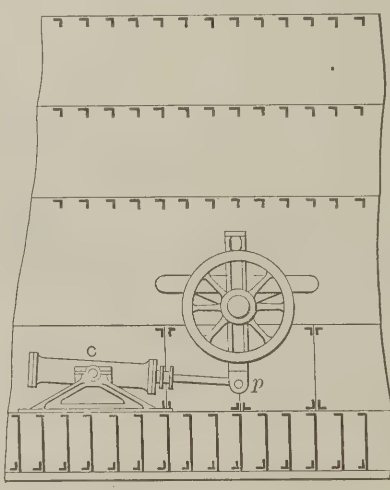

Fig. 11.

Since, as already stated, there is a phase difference of 90 degrees between the swings of the pendulum and those of the axis of the flywheel, the gyroscopic influence on the pendulum must be least in amount when it is passing the middle position—i. e., at the very position at which it has its greatest angular velocity, because at the same moment the inclination of the axis of the flywheel is at its greatest, while the velocity with which it is changing its inclination has become very small or vanished altogether. When, on the other hand, the pendulum has reached its outermost position, and is changing the direction of its motion, thus for an instant reaching a state of rest, the axis of the flywheel then proceeds with its greatest angular velocity through the middle position, the flywheel thereby exerting its greatest influence. It will thus be evident that the conditions for the exertion of the greatest possible influence of the gyroscopic action of the pendulum are not present here. In order that the motion of the pendulum may be effectively influenced, the oscillation of the frame with the axis of the flywheel will have to be reduced in a suitable degree. In the model illustrated in Fig. 9, this may be most simply effected by tightening the screws to a suitable extent, so that they act as a brake on the motion of the flywheel. The swings of the flywheel frame are thus reduced in extent, and the phase difference between the two swinging movements here described now becomes less than 90 degrees.

If the experiment be made of setting the pendulum swinging with the brake thus applied to the flywheel frame, a very different phenomenon will be observed. The pendulum will indeed still swing with a very considerable period, but the maximum angle attained becomes considerably reduced with each successive swing, so that a state of rest is reached even after two complete swings. In scientific language, the oscillations of the pendulum experience a damping, in that the energy stored up in it is destroyed by the friction applied to the flywheel frame.

The gyroscopic action of a rotating flywheel has in the above been illustrated as applied to a pendulum. It will readily be seen that it may be applied in a similar manner to retard the rolling motions of a vessel. In Figs. 10 and 11 the vertical axis of the flywheel *W* is set in bearings in a large frame *F F*, which can turn on the journals *P P*, about a horizontal axis lying at right angles to that of the vessel. It may be made to rotate rapidly by means of an electric motor or a steam turbine.

Fitted to the frame is a journal *p*, which is connected with the piston rod of one or of two hydraulic brake cylinders *C*, and, by the throttling of the area of the communication tube, enables the swings of the frame *F F* to be braked at will. The frame is ballasted at its lower side by a weight *G*, as was done on the pendulum model, or the journals *P P* may be fitted somewhat above the position of the center of gravity of the whole frame. As soon as any outside influence begins to heel the vessel over in a direction at right angles to its length, the flywheel frame will incline considerably, with the result, as in the case of the pendulum model, that moments are produced which not only render the oscillations of the vessel considerably slower, but also very considerably reduce their extent. But these two conditions are exactly the ones which alone are calculated to destroy the rolling motions caused by the waves. A vessel fitted with the appliance illustrated would, according to this, only be subject to insignificant rolling motions. On the other hand, the frame, with its flywheels hung up within the vessel, would swing violently to and fro.

In addition to the hydraulic brake, it will be necessary to fit one or two powerful band brakes, which will enable the flywheel to be held at large angles of, say, more than 45 degrees in stormy weather, which would be under the control of a man told off for the purpose.

In order to show the effect of a flywheel on board a medium steamer, calculations for one of 6,000 tons displacement have been worked out. The vessel has a metacentric height of 17¾ inches and a period of 15 seconds for the double roll when there is no flywheel. Now if on this vessel there be a flywheel 15 feet diameter, weighing 22,000 pounds having a peripheral speed of rotation of 656 feet per second, the effect on the rolling motions is very pronounced. The total weight of the flywheel, with its swinging frame and motor, is taken to be about 45,000 pounds, and the arrangement of the axial trunnions of the frame is assumed in one case to be such that the distance *r* equals 19⅝ inches. Under these conditions the angle of swing is reduced after one oscillation to 0.3, the starting angle. Thus, when the vessel has been inclined 4 degrees from the upright, it will, with the next roll, reach an angle of inclination of only 1 degree, etc.

TOOL MAKING.—6.

TAPS (Concluded).

E. R. MARKHAM.

Pack Hardening.

As the method of pack-hardening steel has proved so satisfactory when used by the writer and also by many others who have adopted it at his suggestion, it seems wise to treat the subject at this time even though it might not be considered as belonging under the head of toolmaking.

It is a well known fact that small, thin pieces of steel can be hardened by heating red hot and dipping in oil, with little or no tendency to spring; but as steel is hardened by *rapid* cooling from a red heat and as *large* pieces of steel cool very slowly in oil, it is generally considered advisable to cool them in water, brine, or some bath which takes the heat quickly from the steel. Now it has been ascertained by experiment that steel can be treated in a manner that insures its hardening when dipped in oil, thus eliminating the danger of cracking or breaking, and reducing to the minimum the liability of springing. This is accomplished by packing the articles with some carbonaceous material in an iron box which should be covered with a flat piece of iron. The space between the edges of the box and cover should be luted with fire clay which has been mixed with water until it is of the consistency of dough. This should be allowed to dry before placing in the furnace or the rapid drying will cause it to crack. Should it crack when drying the cracks may be filled with clay and this allowed to dry.

The carbonaceous material used must not contain any elements that are injurious to tool steel. For this reason do not use *bone* in any form. Bone contains phosphorus, and this is extremely injurious, as it causes the steel to become brittle when it is in combination with carbon. Burnt bone does not contain as high a percentage of phosphorus as the raw bone, but will not give as good results as other material we can use.

If the steel used in making the tool does not contain over 1¼ per cent carbon, "charred leather" is an excellent material to use when packing in the iron box. If steels of higher carbon are used, charred leather does not act as well as charred hoofs, or a mixture of charred hoofs and horns; for charred leather has a tendency to give *high carbon* steels a grain that resembles steel made by the cementation process, when it is subjected to heat for a considerable time. But there is no such effect when charred leather is used in connection with steels that do not contain more than 1¼ per cent. carbon.

Taps are hardened by this process much more satisfactorily than when they are heated red hot and dipped in water. They are tougher, and consequently will stand more strain without breaking. Being tougher they can be left harder, which insures their holding their size longer, and as previously stated the tendency to change size and lead is reduced to the minimum. Do not attempt to pack a number of small taps in a large box, as those in the center of the box would not be in condition to harden when those near the walls of the box were sufficiently charged with carbon. Select boxes sufficiently large to hold a number of taps, yet not large enough to cause uneven heating, as it takes much longer for heat to penetrate to the center of a large box. Do not pack any work so that it is within 1½ inch of the sides, the ends or top or bottom of the box.

As the amount of heat steel receives affects it to a greater extent than is recognized by the average mechanic, it is necessary to watch these heats very closely. High heats have the effect of opening the grain of the steel, making it coarse, and in this condition it is weak. On the other hand it must be heated to a temperature that will insure its hardening when quenched in the bath. This heat should be the lowest possible consistent with results desired, and should not be higher than a low red heat.

The degree of hardness depends upon the length of time the steel is subjected to the action of heat when in contact with the carbonaceous material; and as it does not commence to absorb carbon until it is *red hot* it is necessary to time from the period the steel becomes red. In order to ascertain the time, a way must be provided for finding out when the contents of the box become properly heated *throughout;* and as the center of the box would be the portion furthest removed from the action of the heat in the furnace, we run wires down through holes in the *center* of the cover, and have them extend to the bottom of the box, and project about one inch above the cover, so that they may readily be grasped by the tongs.

When the articles have been packed in the hardening box, the cover put in place, and luted with fire clay, and test wires run down through the holes in the cover, the box is placed in the furnace. After it has been subjected to heat for a period of time which in the judgment of the operator should be sufficient to heat it throughout, reach in with a pair of long-handled tongs and remove one of the test wires. If this shows red its entire length, note the time; if it is not red its entire length, wait a few minutes, then try another. Continue doing this until a wire is drawn which denotes the uniform heating of the entire contents of the box.

The length of time to subject the work to heat after the box is heated throughout depends on the size of the taps. Small taps need not be run as long as the large ones. Taps ¼ inch diameter, if made of most any of the steels ordinarily used for this purpose, should be run from one-half to one hour; larger ones should be run proportionally longer. The condition of the material to be tapped has something to do with the degree of hardness necessary. When they have run the required length of time in the furnace, remove the box, take off the cover, and, by means of blacksmiths' tongs, grasp the taps one at a time by the shank end, and immerse in a bath of *raw linseed* oil, working the taps up and down and around in the oil.

When drawing the temper, if the necessary apparatus is at hand, we can place the taps in a kettle of oil over a fire, heating the oil until the proper temperature has been reached, which can be ascertained by means of a thermometer made for the purpose. Ordinarily if the oil is slowly heated to 460 degrees—which is equivalent to a full straw color—and allowed to remain at that temperature for a little while, the steel will have absorbed the desired amount of heat. It is not advisable to heat the oil quickly and remove the work the moment the thermometer shows the required temperature; for the steel will not take the heat as rapidly as the oil, and as a consequence will be too brittle to stand up well when in use. For some classes of work the temper must be drawn lower than the degree mentioned, say 500 degrees F.—which is equivalent to a *brown* color. However, if the taps are heated carefully to a *low* red when hardening, they may be left harder than when hardened in the ordinary manner.

If we wish to draw the temper "to color" we must brighten the walls of the flutes in order that the colors may be readily observed. If there is no emery wheel at hand the walls of the flutes may be brightened by means of a piece of emery cloth held on a file; but the utmost care must be exercised in order to avoid touching the cutting edges of the teeth, as these would be rounded, and thereby rendered unfit for use. As most shops are provided with emery wheels, however, it is seldom necessary to use emery cloth. The wheel should be dressed to the shape of the flute and sufficient stock removed from the back of the land to smooth it, so that it will not hold chips, and to polish it so that temper colors may readily be observed. Enough must be removed from the face of the land to remove the irregular effect given the face of the teeth—threads—by the action of the milling machine cutter which causes the faces to assume a convex shape; this shape seriously interferes with the cutting qualities of the tool. It is also necessary to remove enough stock to break the burr thrown between the teeth when cutting the groove.

When drawing the temper, heat slowly, or the teeth, which are lighter than the balance of the tool, will absorb heat faster and become too soft, while the body of the tap will have the appearance of being of the desired temper.

Machine Taps.

This term is applied to taps which are intended for use in various machines, as screw machines, turret lathes, tapping machines, etc. They differ from *hand taps* in that the lands are narrower, which is allowable on account of their shanks being firmly held in chucks, or collets, which guide the tap properly, and there is thus no tendency to press the tap to one side. As they are intended to run through the piece being tapped, which in turn is deposited on the long shank, considerable relief *between* the threads can be given them, being careful not to carry the relief to the cutting edge. But if the tap is to run into a hole, then reversed and run out, it is not well to give them much relief, since chips would be drawn into the cavity formed by the relief when backing out.

Taps of this description must be roughed to sizes somewhat larger than finish, then the shank turned to size. They may then be back-rested, the thread end turned to size and the threads cut with an off-set threading tool, which allows the operator to place the back-rest much closer to the portion being threaded than if a straight tool were used.

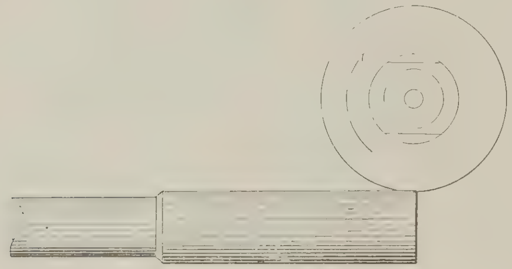
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Fig. 17. Milling the Flutes of a Right-hand Tap.

When machine taps are used for tapping holes that are drilled or reamed, thus insuring round holes, four cutting edges work very nicely; but if nuts whose holes have been punched are to be tapped, better results follow if the tap is given *five* flutes. When five flutes are given a tap the lands must be somewhat narrower than when there are but four, to provide flutes large enough to hold the chips.

Taper Taps.—The same general directions given for making taps of other forms may be observed when making taper taps, but a few points peculiar to this form must be observed.

To have the tap correct as to pitch cut the thread on the tapered surface by means of a taper attachment, rather than by setting over the tailblock. Should we gear the lathe to cut a thread of the desired pitch, then attempt to get the taper by setting over the tail center, we would produce a finer pitch than desired; and if our taper was very pronounced we should have a staggered—drunken—thread. While this is true many taper taps *are* made and threads cut tapering on a lathe where it is necessary to set the center over to produce the desired result. If the threads are well relieved, however, they will work, and answer in an emergency; but do not use this method if a lathe having a taper attachment is available.

Set the threading tool, for cutting the thread of a taper tap, square with a line passing through the centers of the piece, rather than square with the tapered surface. This line is known as the *axis* of the piece.

Taper taps should *always* be given relief between the threads, in order that they may cut, rather than pressing the stock out of the way, as the heel of the thread will drag unless relieved.

Left-Hand Taps.—Left-hand taps are made the same as those having right-hand threads except that the threads are cut left-handed and the cutting faces are on opposite sides of the lands. The same milling cutter may be used in either case. These are made to give the proper shape when starting at the cutting end of tap and running against the work, as shown in Fig. 17, for a right-hand tap. When used for cutting a left-hand tap it must be reversed on the arbor, the machine run in the opposite direction and then commence at the shank end, as shown in Fig. 18. Left-hand taps should always be so stamped that there may be no confusion when picking them out. In some shops they are stamped "Left," while in most places they are simply stamped "L."

When right- and left-hand taps are used in connection with each other in making a universal holder of any description the lead of the two should be alike, and as there is no certainty that any two taps will change alike in lead, even though made from the same bar of steel and treated as nearly alike as possible when hardening, it is advisable to pack-harden them.

Square-Threaded Taps.—This form of tap is not used so extensively as several years ago, having been superseded in many cases by the Acme standard thread. If a full thread is to be made by the passing through of one tap of the square-threaded form, relieve the threads on the top and sides, to do away so far as possible with friction. But if a full thread is to be cut by the use of several taps, make each one a trifle larger than the one preceding it, as otherwise the amount of force necessary for tapping will be in excess of what the tap can stand and it will break. When tapping a long hole by means of several taps of increasing size difficulty is sometimes encountered from the change of lead when the taps are hardened, unless they are pack-hardened.

When possible chase the thread in the hole with an internal threading tool of the proper form, using a finish tap to size the hole. When a tap is to be used for sizing holes which have been threaded *nearly* to size it is not necessary to back them off very much.

Square threaded taps may be fluted the same as V-thread taps.

Hobs for Screw Thread Dies.—This style of taps differs from the forms in general use, in that they have more flutes. In some shops *hobs* are used to remove the entire stock incident to tapping the reamed hole; that is, one hob is made to do the entire job. These are made of two forms: In one case the hob is made tapering for three-quarters its threaded portion, the remaining quarter being straight to retain its size and the threading being tapering and straight as described. In the other case the threading is straight, but the outside is made tapering for about three-quarters the length of the threaded portion.

But in general the hob is simply a "sizing tap" whose flutes are made more numerous so that they may be run into the threading die after the clearance holes are made, to remove any burrs that may have been thrown into the threads.

In order that the hob may not have much work to do when sizing the holes in dies, several taps of the ordinary form are run in ahead of it. These taps should vary sufficiently in size from one another so that any difference in lead would not cause them to produce poor threads. There should also be difference enough in size between the largest of these leading taps and the hob so the hob may overcome any difference in lead, yet not enough difference to cause the hob to remove so much stock that the chips will fill the flutes, causing them to tear the tops of the threads. When hobs are to be used for tapping *solid* dies they must of course be of the exact size of the screw which the die is to cut. When they are intended for tapping *adjustable* dies they may be made a trifle larger. The exact amount cannot be arbitrarily stated but must conform to the practice in the individual shop. This matter will be considered more fully under "Screw Thread Dies."

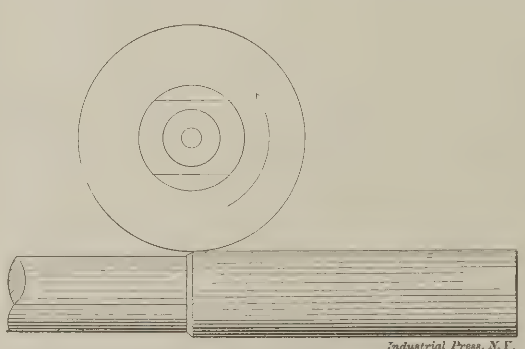
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Fig. 18. Milling the Flutes of a Left-hand Tap.

In order that hobs may work satisfactorily when run into screw thread dies whose clearance holes have been made, make numerous flutes, thus providing more surface of land. The flutes should be very narrow, and the lands correspondingly broad. The number of lands provided varies from 6 to 10, according to the size of the tap—hob.

Adjustable Taps.—Adjustable taps are very useful where holes must be tapped to an exact size, as taps even when hardened in a manner that insures practically no change in diametrical measurements will wear in a short time sufficiently to cause them to be too small. If a tap is made of a form that allows of adjustment the size can readily be changed as it wears.

Very few taps of coarse pitch give satisfaction if made adjustable and a full thread is cut at one passage of the taps. However, they are very useful as "sizing taps," which are to be run through a hole threaded somewhat smaller than finish size.

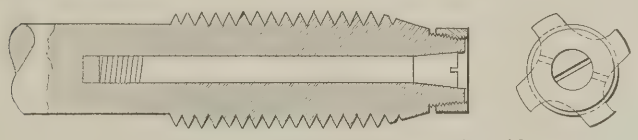


Fig. 19

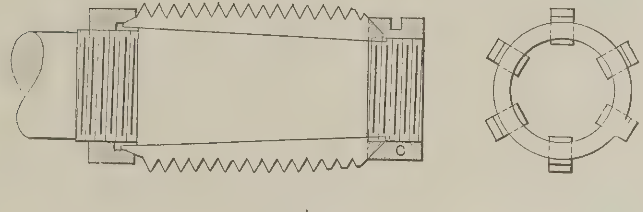
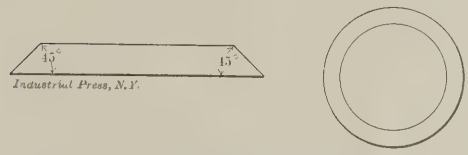


Fig. 20



Adjustable taps are made of various forms, one of the simplest being shown in Fig. 19. The size is altered by means of the adjusting screw shown. However, the various operations involved when making this form of tap are almost identical with those of making the adjustable reamer of similar form and it seems unnecessary to give them.

Adjustable taps are sometimes made having *inserted blades*, as shown in Fig. 20. This form answers nicely for *large* taps, as new blades can be inserted when the first set are worn out at a cost much less than that of making a new tap. The same general instructions given for making reamers with inserted blades will answer for this form of tap. But when milling the slots to receive the blades, cut them somewhat *ahead* of the center, as it will be found necessary to mill 1-32 inch off the cutting face of the teeth, after threading, to remove the portion where the threading tool first came in contact with the face of blades; otherwise the cut would be a trifle deeper at this point and would cause the tap to bind when in use. The face should be milled away sufficiently to make it radial—on a line with the center.

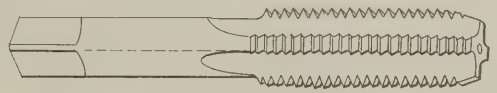


Fig. 21

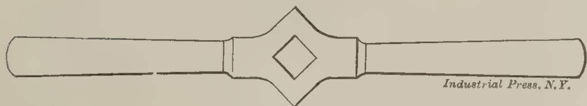


Fig. 22

The threads may be cut sufficiently to make the tap a few thousandths of an inch small. After the blades are hardened they may be placed in position and adjusted to size. The threads having been cut a trifle smaller than finish size give the lands clearance when the tap is adjusted to size.

Tap Wrenches.—To get good results when using a tap it must be held in a satisfactory form of holder. Taps which are actuated by hand, as hand taps, are held in tap wrenches. Suitable wrenches for hand taps must be provided. If a small wrench is used on a large tap the operator is obliged to exert so much force that he soon becomes tired. Then again under such circumstances the operator, instead of applying steady pressure, gives the wrench a succession of "jerks" which have a tendency to break the tap. If too large a wrench is used the operator must be skillful or he will apply more force than he is aware of and will break the tap. Taps are expensive tools and wrenches suitable for them should always be used.

Mill the squares on the wrench end of a hand tap so as to have the corners come on a line with the lands, as shown in Fig. 21; or rather, mill the flutes so the lands will line with the corners of the squares. It is best to mill the squares before threading the tap and cutting the flutes. This is done so that any sideward pressure occasioned by unequal pressure on the handles of the wrench will be compensated for, in a measure, by the land which would support the tap when in the work. Knowing this we make the tap wrench with the corners of the opening to receive the square of the tap, on a line with the handles, as shown in Fig. 22.

Several forms of tap wrenches are for sale. These can be purchased at figures far below the cost of making a single wrench in the shop not equipped for this class of work.

Releasing Tap Holders.—When taps are to be used in turret lathes, or screw machines, they are held in releasing tap holders, by the use of which the tap may be run nearly to the bottom of a drilled hole, or to any desired depth. When it reaches the proper depth the portion holding the tap is automatically released and revolves with the work until the motion of the tap or the machine is reversed, when it again engages with the shank of the holder and the tap is backed out of the work. There are many forms of releasing tap holders. We will consider but one form, that shown in Fig. 23. This is simple and easily made and gives the best of satisfaction when used.

Tools of this character are often made from tool steel. This, of course, answers very nicely, but unless a low grade article is used they are quite costly. A good grade of machine steel, containing 40 or 50 points carbon, answers the purpose as well, will last as long, is sufficiently stiff to resist the strain, and the cost of material is much less. When making the sleeve, *B*, a hole is drilled and reamed the entire length, as shown. This hole must be the size of the tang of the holder, as this tang is to fit in it. The reamed hole must be straight and of a uniform size its entire length. After reaming the hole to size the piece is placed on a mandrel, preparatory to turning to size. Long pieces of work should not be placed on a mandrel having much taper, as the hole being straight would get a bearing only at one end on the mandrel; the other being loose on mandrel, the hole at this end would not be concentric with the turned portion. For work of this class use a mandrel having very little, if any, taper. If no such mandrel is at hand, one can be made at a little expense, simply turning a piece of steel so it can be forced into the sleeve sufficiently tight to hold it while turning. Such a mandrel, however, will not answer for permanent equipment; the center being soft soon wears, and there is the liability of its getting out of shape. However, if care is exercised a soft mandrel will answer very nicely for one piece.

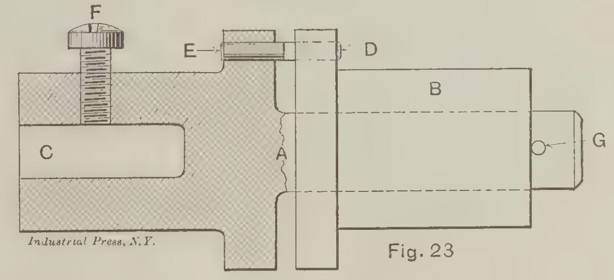


Fig. 23

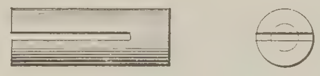


Fig. 24

Unless the sleeve is to be fitted to the hole in the turret by means of grinding, the head (live) center of the engine lathe should be trued before taking the finish cuts, as any eccentricity of the hole in sleeve causes imperfect alignment, and the tools and work must align as nearly correct as possible.

The tap holder, *A*, should be turned to size and fitted to the sleeve, and the large end also turned to dimensions, after which it should be back-rested in the lathe and hole *C* drilled and bored to size. Before strapping the back end of holder to the head or live center, make sure that the center runs true. It might appear to the experienced journeyman that too much stress is laid on this, but an experience of years in instructing apprentices and students has convinced me that too little attention is given this all-important point. Centers in poor condition, and dirt on centers, or in center holes, are responsible for thousands of spoiled jobs.

The hole for pin *D* is now drilled and reamed to receive the pin. After drilling and before reaming, transfer through this hole for the hole for pin *E*, in tap holder, which is reamed with the same reamer. The pins may be made from drill rod hardened and drawn to a blue color, then forced to place. Then the hole for set screw *F* may be drilled and tapped.

Now drill the pin hole in the stem of holder as shown at *G*. This pin should be so located that it will strike the end of sleeve just as the pins *D* and *E* are disengaged. When the motion of the screw machine is reversed the pins will engage with each other and the tap be backed out of the work.

In order to accommodate taps having shanks of various sizes, bushings of the form shown in Fig. 24 may be made. The holes should be a nice fit on the shank of the tap, while the outside should fit the hole in the holder.

* * *

TALK ON LATHE SPINDLES.

F. EMERSON.

The spindle of the engine lathe has passed through an interesting evolution. The pole lathe in general use at the beginning of the nineteenth century had no rotating spindle. The work was mounted on pointed stationary centers and rotated first forward then backward by a cord wound once or twice around it. One end of the cord was attached to a springy pole or lath (hence the name lathe) overhead and the other to the workman's foot, or to a rude treadle.

While the pole lathe was a most primitive machine, the lathes used by the ancient Egyptians were still more primitive. The motive power of these crude tools was furnished by a helper who rotated the work on centers by a cord wound around it, the ends of which were held in each hand and alternately pulled. The pole lathe was thus a decided improvement on the first primitive lathes, as it dispensed with the helper and made it possible for the workman to both turn the work and operate the cutting tools. But the work was turned in an intermittent manner which made the use of tools on it difficult and unsatisfactory. The logical development of the lathe produced the rotating spindle.

The first rotating spindles were made from square iron bars. They were turned down only a short distance for the head bearing. The tail end of the spindle was supported by a pointed setscrew bearing in a cupped center. A grooved pulley of one step was mounted on the square spindle and driven by a belt from a wheel of larger diameter mounted on a shaft. The belts or bands were made from catgut. It appears to have been the practice at first to place the wheel at one side, a helper turning it by a crank. Then followed the drive wheel with crank and treadle placed below the spindle so as to make the machine operative by the workman himself.

The use of the pointed setscrew for the tail bearing served two purposes. It supported the spindle on a pivot bearing which gave the least friction, and it made a convenient means of adjustment for end wear. The end wear of the spindle against the sides of the head box seems to have been the source of considerable trouble. One early amateur who has written on the subject lugubriously complains of the burring or rumbling sound made by the square corners of his lathe spindle, grinding into the side of the box. Collars were found to overcome this fault, but for good reasons were not at first generally adopted. The necessity of cutting screws complicated the spindle problem and brought forth features which now seem grotesquely absurd.

The possibility of cutting screws in the lathe seems to have been understood at a very early date. Many schemes were devised for the purpose, among which was the most popular one at one time of moving the spindle longitudinally in its bearing. By having a screw cut on the spindle and engaging a wooden half-nut with it, the spindle would move longitudinally as it turned and generate a screw of the same pitch on the work held in a chuck as it passed before the point of a stationary tool. During screw cutting the setscrew supporting the tail end of the spindle was backed away to give it free longitudinal motion. The spindle was then only supported by the head bearing and the wooden half-nut bearing on the under side. Little less than the patience of Job was required to make screws by this jiggley arrangement, but they were made in a passable manner, which is an indication of the patience and skill of the early artisans.

Bearing this in mind it is quite apparent that the use of screws as "stitches" for uniting the parts of machines was greatly hampered in the early days by lack of suitable means for cutting threads. But the demand for these indispensable parts was so insistent that the lathe must be developed so as to make them in a more rapid and satisfactory way. Hence the invention, attributed to Maudslay, of the screw-cutting lathe having a leadscrew connected to the spindle by change gears. But the pointed setscrew bearing was retained long after this time because of its adjustability and little frictional resistance to driving. It must be remembered that few lathes were driven by power in the first years of the nineteenth century; almost all of them were worked by foot power, and the matter of friction was a serious one. As lathes developed in size, however, the pointed setscrew bearing was finally

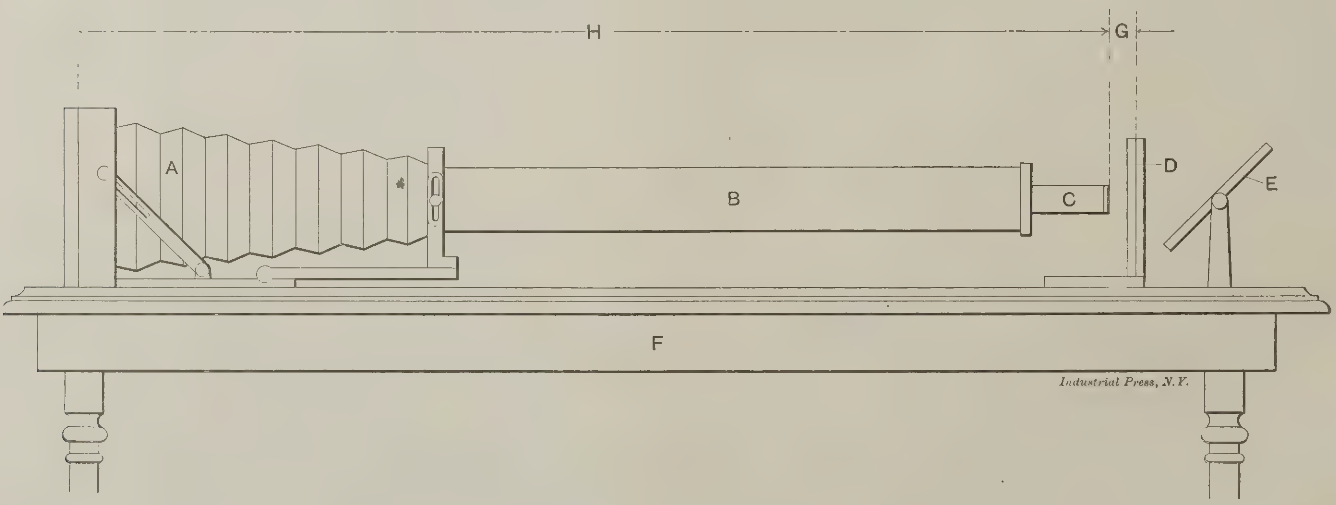


Fig. 1. Homemade Apparatus for Microphotography.

abandoned for a small diameter cylindrical bearing at the end of the spindle, which feature is still retained in modern lathes, for good reasons—perhaps.

In the primitive lathe the conical point or center was made solid with the spindle. Removable centers were first made to screw into a hole bored in the end of the spindle, and this threaded hole was also employed for fixing chucks, the chucks and faceplates being made with threaded shanks or spindles instead of the threaded socket commonly used now. The extension of this hole through the spindle to make the hollow spindle is probably due to chance rather than design, although the desirability of such a construction was, no doubt, appreciated by early mechanics; the difficulty of boring a hole through the spindle must naturally have prevented its being done. But when some gunsmith set out to make a lathe for his own use he would quite naturally have selected an old musket barrel for the spindle, and in that he had a hollow spindle as good as though made to order. His lathe was the pattern for others, and so this idea and others slowly spread—how slowly is quite difficult for us to appreciate now.

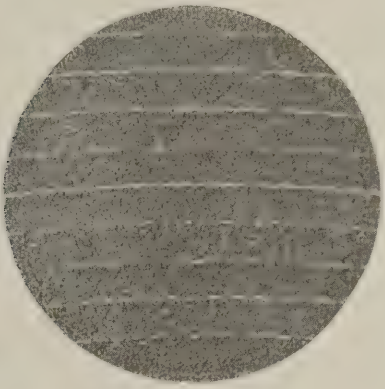


Fig 2. Spiral Circle Emery Paper—Full Size.

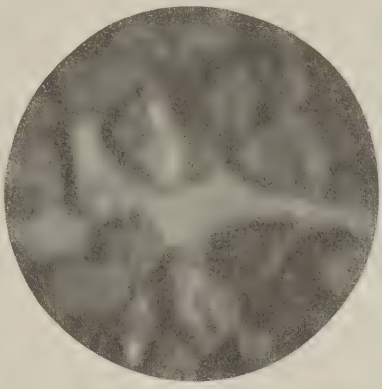


Fig. 3. Spiral Circle Emery Paper, Magnified 100 Diameters.

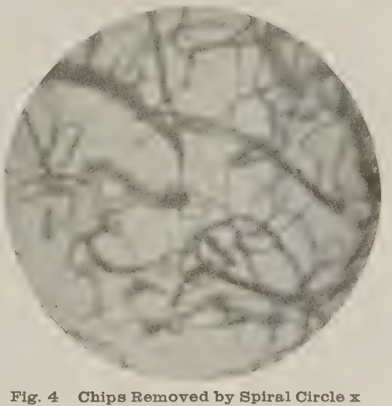


Fig. 4 Chips Removed by Spiral Circle x 100 Diameters.

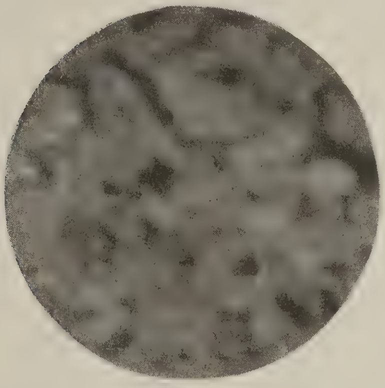


Fig. 5. Sandpaper x 100 Diameters.

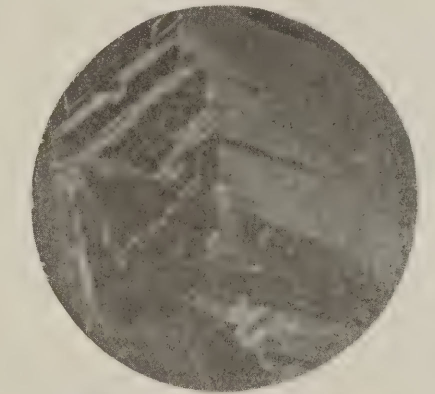


Fig. 6. Antimony x 10 Diameters.

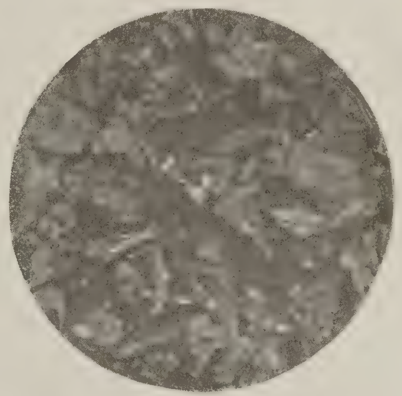


Fig. 7. Carborundum x 100 Diameters.

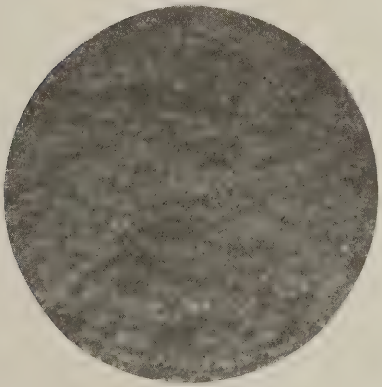


Fig. 8. Cast Iron x 10 Diameters.

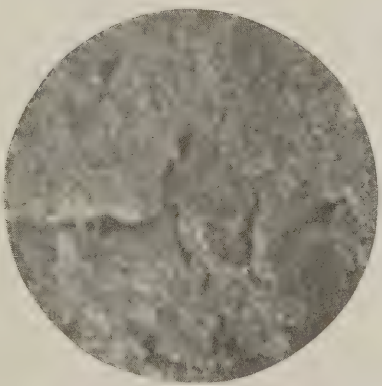


Fig. 9. End View Wrought Iron x 10 Diameters. Broken at 70,600 lbs. per square inch.

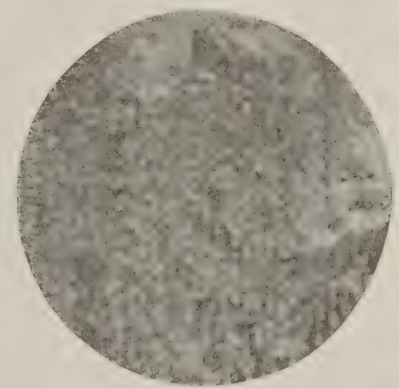


Fig. 10. Side View (Wrought Iron x 10) of same piece broken in Testing Machine.

* * *

MICROPHOTOGRAPHY.

W. H. SARGENT.

There is a feeling among many people that while microphotography is an interesting, agreeable and instructive art, yet that it requires expensive apparatus and is difficult of operation. This is doubtless true where enlargements of extremely high magnification are to be made, as when bacteria are to be photographed to a scale of 1,000 diameters, which is the standard for this class of work. But I have been making some interesting experiments with a cheap home-made outfit, examining some of the commonplace objects which are to be found every day in the shop, and enlarging them, although not to a very large scale and have been quite successful.

My apparatus is shown in Fig. 1, *A* being an ordinary 4 x 5 camera with the lens removed and in its place a piece of pasteboard mailing tube *B* about 20 inches long. At the end of this tube is the lens *C*. This was the subject of many experiments. The ordinary camera lens at this point magnifies about six times; the lens from a pocket kodak, about 10 times; and the eyepiece from an ordinary telescope, about 100 times. By "times" is meant diameters, and the amount of magnification may be found by dividing *H* by *G*, the same as the multiplication of a lever may be found by dividing the long arm by the short arm. The shorter the fulcrum distance the more the lever multiplies; the shorter the focus of the lens the more the camera magnifies. I have tried lenses from surveyors' levels and transits with surprisingly good results, considering that these lenses were not designed for photographic work and that the chemical and visual rays were not corrected to focus at the same point. The object to be photographed was held between two glass plates *D*, and if it was transparent a mirror *E* was placed behind so as to throw the light through the subject onto the lens. If opaque, the mirror was placed at one side so as to throw the light on to the front of the object. In all cases a bright light was found necessary, since the light coming on one square inch would, if we were magnifying 10 times, be distributed over 10 x 10 or 100 square inches. Soft sunlight was found the best; lamplight would not answer at all. Ordinary photographic plates were used and the time required was from two to four minutes. Great care was required in focusing, a grain of emery appearing so large that it was difficult to get the top and bottom in focus at the same time. It was also necessary to fasten the outfit to the table to prevent vibrations which would of course be magnified in the same ratio as the object.

* * *

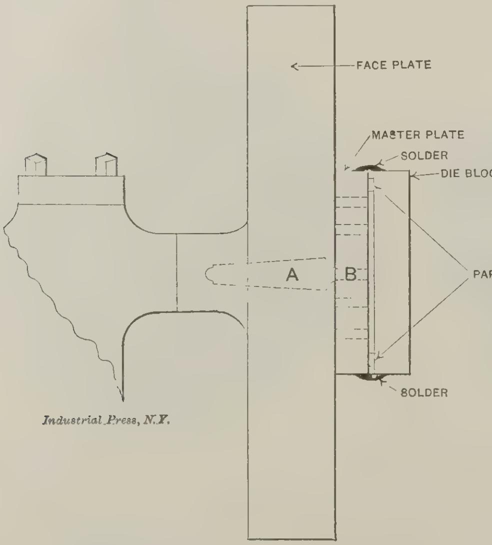
A FEW SUGGESTIONS IN TOOL-MAKING.

FRANK E. SHAILOR.

Frank E. Shailor.

Oftentimes the output of a factory necessitates four or five jigs or dies that must be exactly alike. Now to make a number of jigs and dies that will perfectly interchange is no mean job. The very best method that has come under the writer's notice for exactly duplicating any number of jigs or dies is the use of the "master-plate."

The master-plate is made either of cast iron or machinery steel and contains the same number of holes, in the same relative position, as are to be in the jig or die. Into these holes are forced hardened steel bushings that have been lapped to a given size and ground outside concentric with the holes. In making the master-plate the greatest possible care should be exercised in making same as accurately as is possible. Further, if the jig is to produce exceedingly accurate work, the master-plate should be made of steel that has been thoroughly "aged." Brown & Sharpe Mfg. Co. state that it requires about eight years for a piece of steel to thoroughly age, or settle, of its own accord. But, it has been found that by removing all scale and placing the steel on the base of an electrical generator, which subjects the steel to constant vibration and ever-changing temperature the steel will age in about six weeks time. Another way of aging steel frequently used, is the "hot and cold water" method. The steel so treated is first worked to within 0.01 inch of the finished size, and is then immersed in a bath of boiling water which causes it to expand. Then it is dipped into ice water to cool it. This operation is repeated perhaps one hundred times, and the repeated expansions and contractions cause the molecules to settle into permanent form. Using this precaution of aging the steel obviates the danger of the master-plate changing form after same is finished.

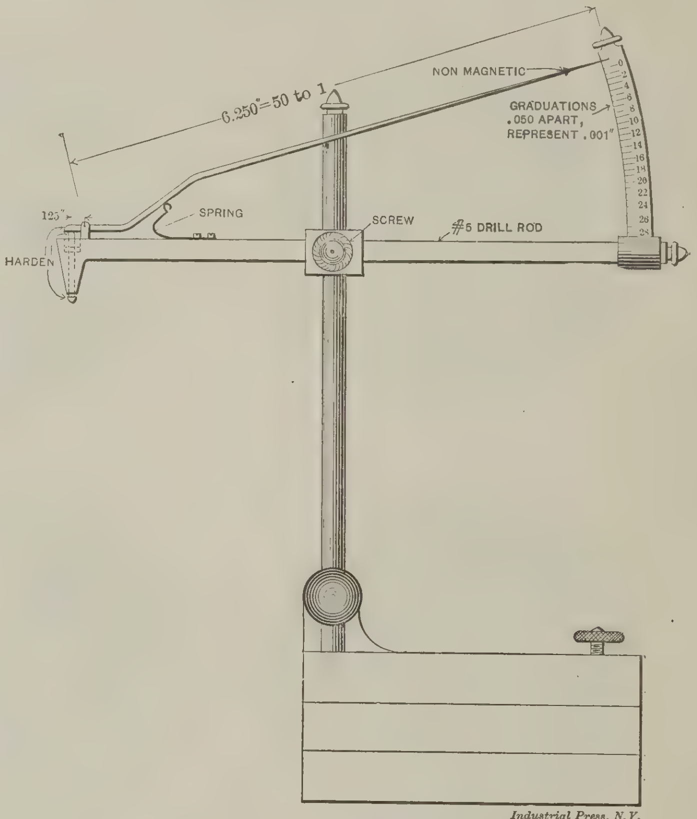


Industrial Press, N.Y.

Fig. 1. Making a Die from a Master-plate.

To return, let us assume that the master-plate is completed and is as nearly accurate as it can be made; we may even grant that a slight personal error has crept in caused by uneven tension on micrometer screw, when measuring, but if the error is so slight that it will not materially affect the finished product, and the master-plate is adopted as the shop standard and all jigs and dies are made from the master-plate it is evident to all that the jigs and dies will contain that slight error also. But each jig or die will be an exact duplicate, and interchangeable. To make a die or jig from the master-plate is as follows:

Select a lathe with perfect bearings and carefully face off the faceplate. Do this only on the lathe where it is to be used and do not disturb the faceplate until all the work on the jigs is finished. Next a center, *A*, Fig. 1, is made of machinery steel to fit the taper in the spindle of the lathe, and to project beyond the face-plate plus the thickness of the master-plate. The end, *B*, of the center is then carefully turned (not filed) to closely fit the holes in the master-plate. The die block is then fastened to the master-plate by means of a small amount of solder at each end—the die block separated from the faceplate by thin parallels, as shown. Starting at hole No. 1 the master-plate is wrung on the center until the master-plate rests firmly against faceplate, in which position it is securely clamped. The die block is then spotted, drilled and bored. It needs no further argument to convince the reader that the hole in the die block is directly opposite the hole in the master-plate. By repeating the above operation until all the holes are bored in the die block the master-plate can then be laid away until called upon to duplicate a die or jig. The same method is applicable to numerous other jobs, such as fastening the punch holder to the die and using the die as a master-plate to transfer the holes into the punch holder, etc.



Industrial Press, N.Y.

Fig. 2. Multiplying Gage or Indicator for General Work.

Gages, Hand Reamers and Arbors.

To insure a plug or ring gage, hand reamer, or arbor remaining true and to size it is necessary to work the article to within say 0.01 inch of finished size, harden, and age same by placing it where it will be constantly jostled about (preferably on the base of an electrical generator) for at least six weeks' time before finishing. Undoubtedly a great many readers will say that this extra precaution is unnecessary, but when a piece of steel is hardened there are internal strains set up, and if said strains are not entirely removed the finished gage will be anything but satisfactory. Only those who have had experience making gages know the poor results obtained by making a plug and ring gage from an unsettled bar of steel. All arbors, reamers, gages, etc., turned out by standard tool-making concerns are thoroughly treated in above manner. The warranted surface plates manufactured by Brown & Sharpe Mfg. Co. are eight years old before they leave the factory. The above is cited merely to show that it is necessary to "age" steel if a gage is to remain a standard.

Grinding and Lapping.

When making gages, reamers, spindles, or any tool that has to be ground, it is better to leave considerable stock to be ground off than to finish within say, 0.005 inch and be obliged to pene the tool in order to straighten it sufficiently to "clean up." It is possible to pene a piece of steel that has sprung in hardening so that it will run true, but pening simply compresses the stock where pened, making that part stiffer and holding a set in the steel so that it runs true; but just as soon as the least bit is ground off, the pening loses that much of its effect and the steel partly returns to its bent form. Therefore it is better to make a larger allowance for grinding than a small allowance for pening.

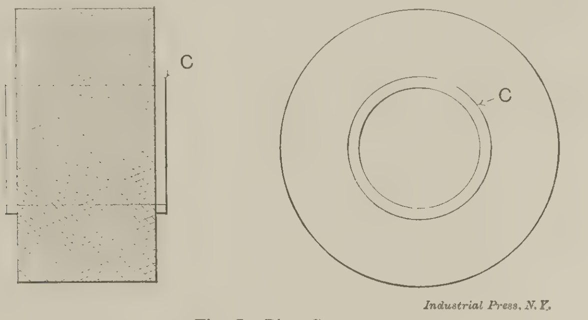


Fig. 3. Ring Gage.

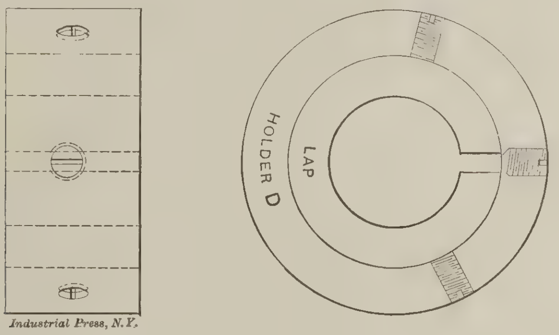


Fig. 4. Outside Lap.

The emery wheel receives less attention than is necessary to produce good work. It is a mistaken idea among some toolmakers that to obtain a nice smooth surface it requires a very fine wheel. A fine-grained wheel glazes very quickly and then bounds along on the work, cutting only here and there, altogether leaving a very untrue and rough surface. On the other hand a coarse wheel (that runs fast enough) will cut freely and smoothly, owing to the keener cutting points and more numerous and larger recesses for debris to gather without impairing the cutting points in the least. Satisfactory results are sometimes obtained by using water on a fine wheel; but very seldom when run dry. Different diameters and surfaces require different allowances for grinding. A 1-inch plug gage that has a good smooth surface needs only about 0.0015 inch for lapping.

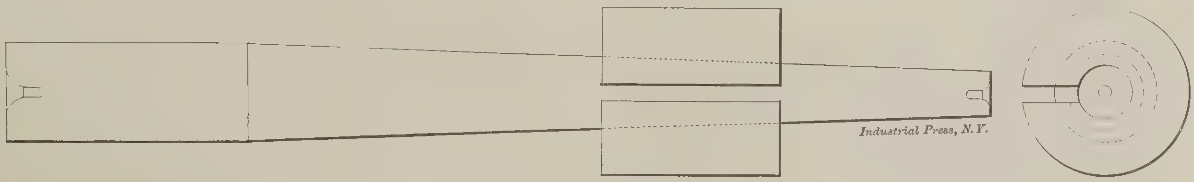


Fig. 5. Inside Lap

The outside lap, shown at Fig. 4, should be made of cast iron, copper or lead, and the holder *D* should be provided with adjusting screws. The flour emery used should be sifted through a cloth bag to prevent any large particles of emery entering the lap and scratching the gage. After sifting the emery it is mixed with lard or sperm oil to the consistency of a thin paste. The gage is then gripped in the chuck of the lathe by the knurled end and smeared with emery paste. The lap is adjusted to fit snugly on gage and the lathe is speeded up as fast as possible without causing the emery to leave the gage. The lap requires constant adjusting, to take up the wear of the lap, and reduction in size of the gage. When measuring the gage it should be measured at both ends and in the center to make sure that it is not being lapped tapering. When the gage has been lapped to within 0.0002 inch of finished size, allow the gage to thoroughly cool and then by hand lay lengthwise of gage to the finished size. By so doing all minute ridges that are caused by circular lapping are removed, thereby leaving a true surface and also imparting a silvery finish. A gage should never be lapped to size while warm (caused by friction of lap), because the gage expands when heated and if lapped to size it will contract enough to spoil it.

In grinding out the inside of a ring gage considerable difficulty is experienced in adjusting the grinder so that same will grind straight. One way to prove the straightness of a hole being ground is to move the wheel over to the opposite side of the hole until wheel will just barely "spark." Then, beginning from the back of hole, feed out, and if the hole is tapering the wheel will either cease to spark, or will spark considerably more. Another and better way is by means of the multiplying indicator gage, Fig. 6. By fastening the indicator to the spindle of the grinder and placing the contact pin of indicator on the opposite side of the hole and feeding in and out, the pointer will record in thousandths of an inch just what the deflection is.

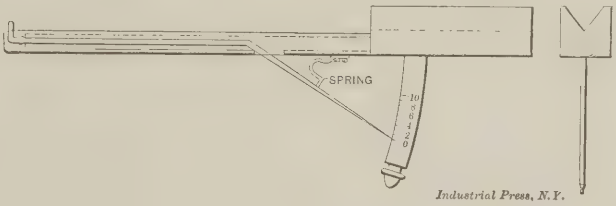


Fig. 6. Multiplying Gage for Testing Holes for Parallelism.

A ring gage should be made as shown at Fig. 3, the object being to prevent the gage becoming "bell muzzled" while lapping. After gage is finished the thin projecting web *C* is ground off, leaving a good straight hole. The lap used for inside work is shown at Fig. 5. The lap can be made to always fit the gage by merely forcing the lap further along on the taper arbor. The lap being slotted allows same to expand. In making a ring gage having a taper hole or a taper plug gage, it is necessary to employ a different method for lapping, as it is impossible to lap a taper hole with a taper lap. The facts regarding lapping are these: First, the lap must fit the hole at all times, secondly, the lap must constantly be moved back and forth. Therefore, if a taper lap is made to fit the taper hole it will lock and not revolve. If held in one place the lap will quickly assume the uneven surface of the hole. If the operator attempts to lap a taper hole by constantly revolving the gage on a straight lap he will surely dwell longer in one place than another, thereby making a hole that is anything but round. The writer suggests the following method: Having ground the hole to size, plus allowance for lapping, and without disturbing position of slide rest or grinder head, change the emery wheel for a lap made of copper—same shape as emery wheel with the exception of having a wider face—and lap in same manner as hole was ground, care being taken not to "crowd" the lap.

* * *

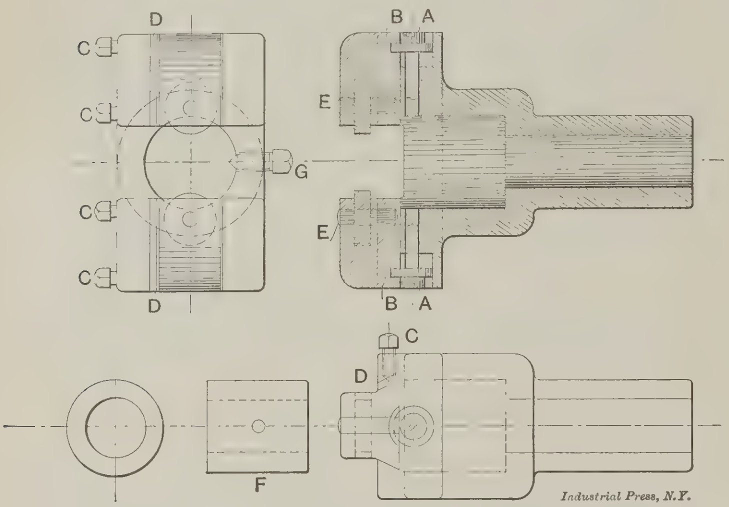
Plans for a model foundry, to be carried on in connection with the St. Louis Exposition next summer, by the Worcester Polytechnic Institute, are now completed and it is expected that the construction of the building for that purpose will begin very soon. The entire charge of the foundry throughout the summer will be in the hands of the Institute.

LETTERS UPON PRACTICAL SUBJECTS.

KNURLING TOOL FOR TURRET LATHE.

Editor MACHINERY:

The accompanying drawing shows an adjustable knurling tool for the turret lathe. I have found this tool very useful, and I send it in the hope that it may interest some of your readers. The head of the holder has a slideway planed across it, into which the mild steel blocks carrying the knurls slide. They are adjusted to and from the center by means of the screws *A A*. The collars on the screws fit into the notches *B B* in the blocks. After the blocks carrying the knurls have been adjusted to the required size, they are locked in position by means of the screws *C C C C* pressing on the strips *D D*. The pins *E E* on which the knurls run are made of tool steel and should be hardened and ground. The large hole in the body of the holder is to enable work of large diameter to be knurled. The hardened and ground bushing *F* fits the large hole and is held in position by the screw *G*. This bushing is used when the work being knurled requires supporting, which is sometimes necessary. The tool being adjustable enables the knurls when they become worn to be softened and recut, which, of course, could not be done without losing the size if the tool was not adjustable. CHERRY RED.



Adjustable Knurling Tool.

PIPE JOINTS FOR SUPERHEATED STEAM.

Editor MACHINERY:

As superheated steam has come to stay, suggestions as to how it can be best conducted from superheater to engine, are timely; for owing to its high temperature, equivalent in some instances to iron at a cherry red, all soft joint and rod packings must go. Then, too, its high temperature has multiplied the expansion and contraction of all the parts it touches. With saturated steam, the changes in shape due to differences in temperature, were allowed to take care of themselves, but when using highly superheated steam, this cannot be done, and flexible piping from superheater to engine at least is a necessity.

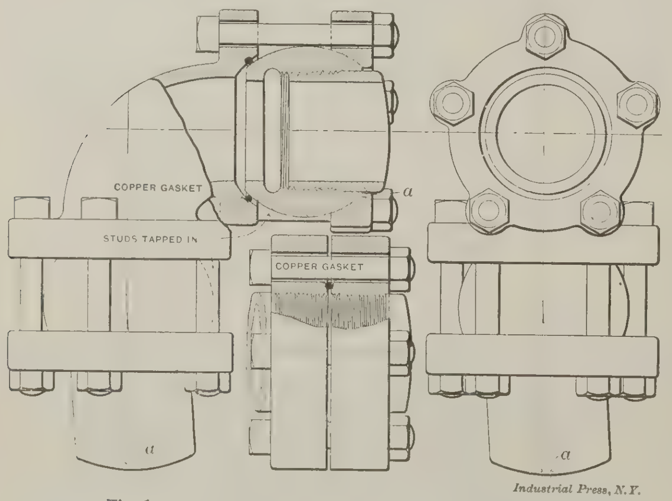


Fig. 1. Fig. 3. Fig. 2.

In the illustration, Figs. 1 and 2 are of an elbow with a ball and socket joint, with a copper wire gasket let into the elbow. The ball should be surface hardened and ground true and smooth, so that the slight movement between the surfaces of ball and gasket will not abrade either. It will be noted that the pipe, in the sectional part of Fig. 1, is screwed into the ball as far as the shouldered end of the thread will allow, which leaves the pipe about as strong as though no thread had been cut on it. The distance *a* shows the limit of flexibility of the joint. This elbow, owing to its swivelling nature, makes an expansion joint in the line, in as many directions as are needed to relieve the pipe of extraneous strain. Fig. 3 is a flange union with a copper wire gasket let into each flange.

For the elbow, it is recommended to paint the ball occasionally with black lead. AMOS PRICE.

WRIST-PIN TURNING MACHINE.

Editor MACHINERY:

Many times in my past experience I have wished for something better than the ordinary engine lathe for turning the wrist-pins of crossheads. An opportunity finally was afforded me to devise something for doing this work, and a machine was built. Since then I find many others have been thinking along the same lines, and wrist-pin turning devices in varied forms have been the result. It may be of interest to those who propose wrestling with this problem, as well as those who have produced machines, to see a description of the one I designed, and to such the accompanying drawings will be sufficiently well understood without any lengthy description of same.

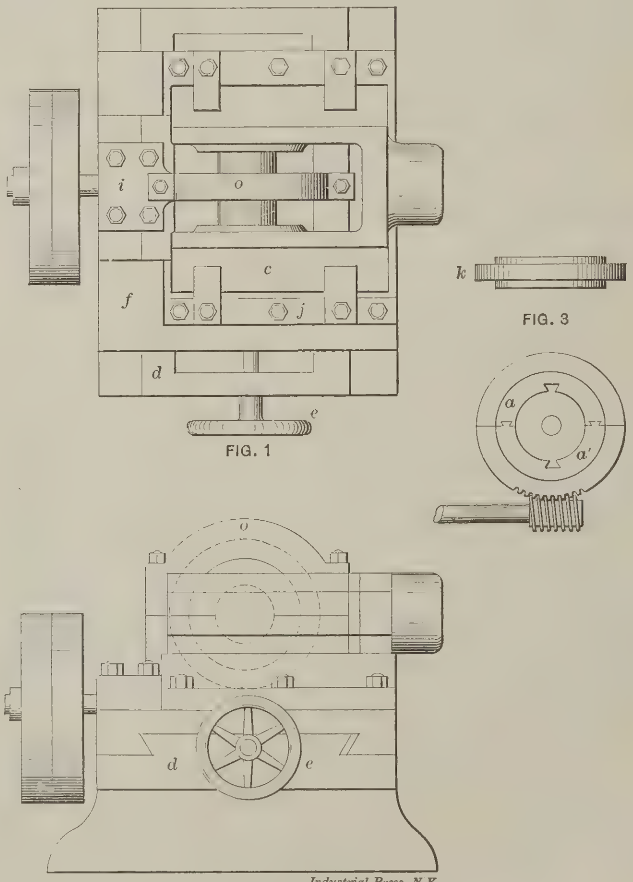


FIG. 1 FIG. 3 FIG. 2

Wrist-pin Turning Machine.

Fig. 1 is a plan of the machine and Fig. 2 is a side elevation. Fig. 3 shows the annular cutter ring with its worm driving shaft. This ring, of course, must be made in halves, and is held together by dovetails, as shown at *a a′*. The dovetailed slots on the inside of this ring are for holding turning tools. This ring is fitted neatly to the casing *o*, Figs. 1 and 2. This casing is securely attached to the platen *d* at *i*, and the crosshead, being mounted on the carriage *f*, is moved from side to side by the hand wheel *e* during the process of turning. The crosshead is planed before coming to this machine, so that by means of a suitable jig, *j*, it is readily placed squarely with the planed surfaces.

It is apparent that the scope of such a machine must be limited to a few sizes of crossheads. With the conditions met with in the larger classes of steam engines, an entirely different construction is necessary. For example, in the works of Mackintosh, Hemphill & Co., Pittsburg, Pa., three such machines are in use, with capacities for turning wrist-pins, or journals, ranging from 10 to 24 inches diameter. The design of these machines is their own, and they are admirably adapted to the work they have to do.

Quirk.

FRACTIONAL THREAD CUTTING AND COMPOUNDING.

Editor Machinery:

After reading Mr. F. H. Colvin's article in the November number, I was asked by a shopmate to explain some points in it that he failed to understand, and after thinking it over I thought I would "butt in" on the subject in Machinery.

Now in cutting fractional threads with 3 or 5 lead screw it is not so easy to figure out the gears, so why not try another way, and that is, carry out any fractional pitch to whole turns in whole inches. Thus in a screw thread ¾-inch pitch there are 4 turns in 3 inches; then with a lead screw of 3 pitch we have 9 threads in 3 inches. So we can put it down like this:

$$\frac{9 = \text{number of threads in 3 inches of lead screw}}{4 = \text{number of threads in 3 inches of the work}}$$

We can multiply both by any number to get the gears, say 6. Then we have as follows:

$$\frac{9}{4} \times \frac{6 = 54 \text{ the driver}}{6 = 24 \text{ the driven}}$$

A lead of 13-16 inch is just as easy, as we can see that it is equivalent to 16 turns in 13 inches, and in 13 inches of the 3 lead screw there are 39 turns. On putting it down as before we have:

$$\frac{\text{Threads in 13 inches of lead screw } 39}{\text{Threads in 13 inches of the work } 16} \times \frac{2 = 78 \text{ driver}}{2 = 32 \text{ driven}}$$

So when we get a thread of 1 7-16 inch lead to cut we can carry it to full turns in whole inches. Then we find it is 16 threads in 23 inches and in 23 inches of the 3 lead screw there are 69 turns. So we can proceed as before and we have as follows:

$$\frac{69}{16} \times \frac{2 = 138 \text{ driver}}{2 = 32 \text{ driven}}$$

If we do not have a gear as large as 138 we shall have to compound.

Again, in cutting a thread of ¾ turn in one inch we see it is 1½ turns in 2 inches and 3 turns in 4 inches of the work. Then in 4 inches of a 3 lead screw there are 12 threads, so we put it down as before and multiply by any number, say 8. Then we have

$$\frac{12}{3} \times \frac{8 = 96 \text{ driver}}{8 = 24 \text{ driven}}$$

By this method of finding the gears we do away with fractions and the necessity of finding the common denominator. All we have to do is find the least number of inches that contain whole threads, and find how many turns the lead screw contains in that many inches. Then select our gears in the same proportion. The gear in proportion to the lead screw goes on the stud and the gear in proportion to the thread on the work goes on the lead screw.

About five years ago I saw an article on the compounding of gears in Machinery that was very simple and easy to handle. We first put down pitch of the lead screw, and under it in the form of a fraction the number of the thread we have to cut, thus:

$$\frac{4 \text{ pitch of lead screw}}{18 \text{ pitch of thread to be cut}}$$

Then find two numbers which, multiplied one into the other, will equal the lead screw, and do the same with the number of the thread to be cut, thus:

$$\frac{4 = 2 \times 2}{18 = 3 \times 6} \text{ or } \frac{2 \times 2 \text{ drivers}}{2 \times 9 \text{ driven}}$$

We can multiply all round by the same number if convenient, or, if not, either pair may be multiplied by any number, and the other pair by any other number. (By a pair I mean a driver and a driven.) We multiply first by 10. Then we try the other by any two numbers, thus:

$$\frac{4 = 20 \times 20}{18 = 30 \times 60} \text{ or } \frac{2}{2} \times \frac{12 = 24}{12 = 24} \text{ and } \frac{2}{9} \times \frac{8 = 16}{8 = 72}$$

In the second example we have a driver and a driven the same. So we double up the driven and the other driver. Then we have it like this:

$$\frac{24 \quad 32 \text{ drivers}}{48 \quad 72 \text{ driven}}$$

But if it happens that we have a 3 lead screw instead of a 4 lead screw we can put it down like this:

$$\frac{3 = 3 \times 1}{18 = 2 \times 9} \text{ from whence}$$

$$\frac{3}{2} \times \frac{12 = 36}{12 = 24} \text{ and } \frac{1}{9} \times \frac{10 = 10 \text{ drivers}}{10 = 90 \text{ driven}}$$

But we have not got a 10 gear, so we proceed as follows: Multiply the 10 and 24 tooth gears by 3, which gives the following:

$$\frac{36}{24 \times 3 = 72} \text{ and } \frac{10 \times 3 = 30 \text{ drivers}}{90 \text{ driven}}$$

We now have a pair of gears in the proportion of 1 to 2 and the other pair as 1 to 3. If we do not have the gears called for in the trial we can note the proportion between any driver and driven, and select accordingly.

Elmira, N. Y.

John A. Burgess.

GRADUATING CROSS-FEED SCREWS.

M. H. Ball.

Editor Machinery:

The accompanying cuts show ways of graduating the cross-feed screws of lathes or the feed screws of planers, shapers, milling machines, etc. This is not offered as a substitute for a tool that is already graduated, but as a simple way by which it may be accomplished on a tool that is without graduating screws.

The collars shown at *A* and *B*, Fig. 1, next page, are very convenient, as the lines show very distinctly at the position the operator is likely to be in when making adjustments, and I think in most cases it is well to follow this design, although the graduating can be and is sometimes put on the outside of a straight-faced collar and face of slide casting against which the collar rests.

Fig. 3 shows the tool for doing the spacing. It consists of a disk (a small section of which is shown) of sheet iron of not less than 12 inches in diameter (larger is better) with a hole in the center to fit over the hub of the collar on the screw. On the disk is a circle accurately spaced off to the required graduations, and a pointer *D* fitting closely over the screw *S*, with its point *E* and marking edge *F* thinned down, as shown, to assist in accurate setting and marking. The marking can be done very satisfactorily with a scratch awl. If other shaped collars are used the pointer must be shaped at *F* to conform to their shape.

Fig. 1 shows a collar for a four-pitch screw graduated in sixty-fourths and thousandths. The collar *A*, which is fast to the screw is graduated in sixty-fourths, and the collar *B*, which is fast to or a part of the slide is graduated in thousandths for a distance of one of the sixty-fourth spaces.

Fig. 2 shows a six-pitch screw graduated in the same way, but this, of course, does not come out even like the four-pitch screw, and, as will be noticed, the space between 0 and 10 is shorter than the rest. Still this comes very handy for small adjustments.

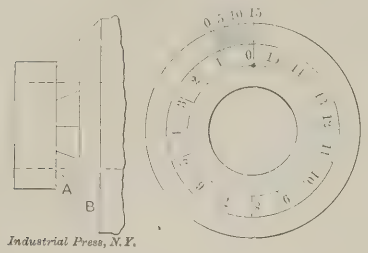


Fig. 1.

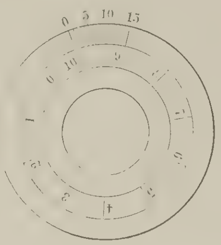


Fig. 2.

The unequal divisions in Fig. 2 vary so much from the rest that I think it is not likely to be the cause of a mistake being made by the difference not being noticed, and in regard to a mistake being made by an error in reckoning, I think that this is not very likely to occur on account of the graduations being used mostly for *small adjustments*. If large adjustments are wanted (unless they run in half or even inches) I must confess this to be rather perplexing, but have used this with very satisfactory results and have not found anything better for a six-pitch screw. Of course, the four-pitch is the ideal screw to graduate in this way, but I would much rather have the graduated screw than the plain, whatever the pitch.

M. H. Ball.

Watervliet.

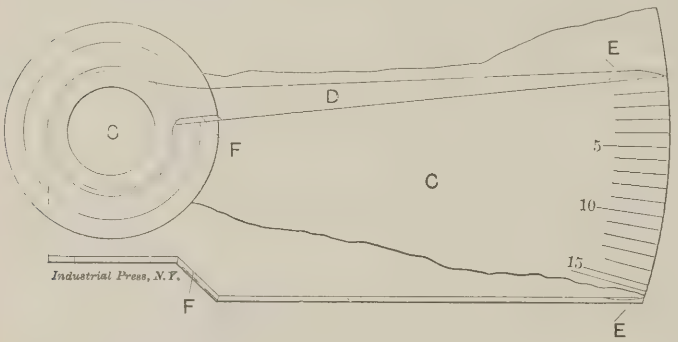


Fig. 3. Tool for Graduating Cross-feed Dials.

TURRET LATHE TOOLS.

Editor Machinery:

A remark made to me by a pattern maker, to the effect that in his thirty years' experience he had never seen a similar tool before, is the reason for describing such a well-known tool as the undercut (forming) tool here illustrated.

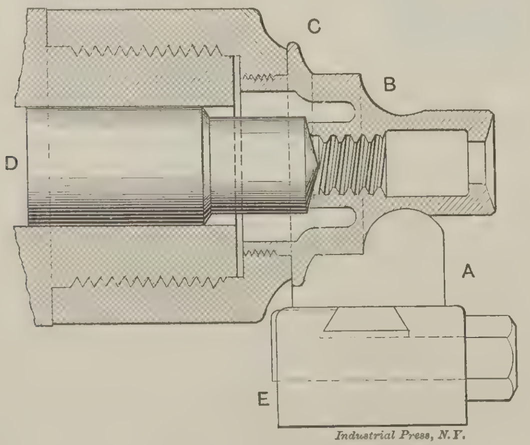
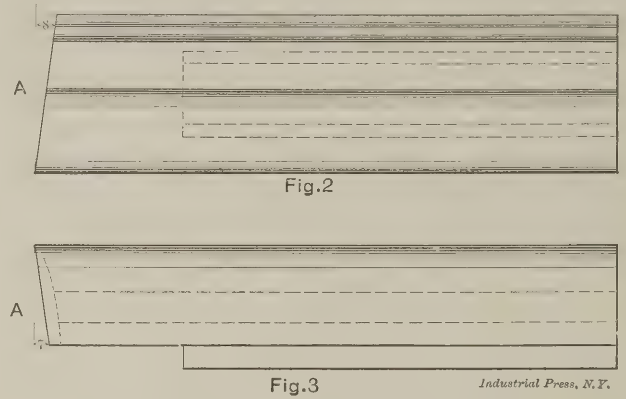


Fig. 1. Chuck and Forming Tool.

The function of this tool is the forming and finishing of the bonnet of the ordinary steam valve, a cross-section of which is seen in Fig. 1. This figure also represents a section of a chuck and the nose of the spindle of a turret lathe.

The bonnet *B* is screwed into the chuck *C* until it shoulders. The plunger *D* is then forced against the housing of the screw in the bonnet by the lever and mechanism used for closing spring chucks in these machines. This movement locks the bonnet against the thrust of the tool and the reverse allows it to be readily unscrewed by hand after the cut is made.

The tool *A*, Figs. 1, 2 and 3, is made the shape desired, and is held in the shoe *E*, Fig. 1, by a hook bolt. The shoe *E* has a clearance of 1-16 inch in a length of 6 inches. These tools when properly made give a fine finish to the work, do it fast, and will last a long time. The cutting angles of entrance and clearance are 8 degrees and 7 degrees respectively.



Top and Side Views of Forming Tool.

It is often necessary to make a second operation on screw machine work, which will require re-chucking. If the pieces are short, Fig. 4 shows a good method of doing this. *A* is a cross section of a screw machine collet, and *B* is a stop piece. It is made to slip easily into the spindle of the machine and also to be a loose fit in the collet. Its length will, of course, be made to accommodate the work it is to support. The flanged end is forced against the collet by the plunger *C* and the work locked in the chuck in the usual manner. It may in some cases be necessary to drill a hole through the center of *B* to accommodate some classes of work, but in any case the re-chucking can be accomplished in much better time and with equal accuracy to that of using a stop in the turret.

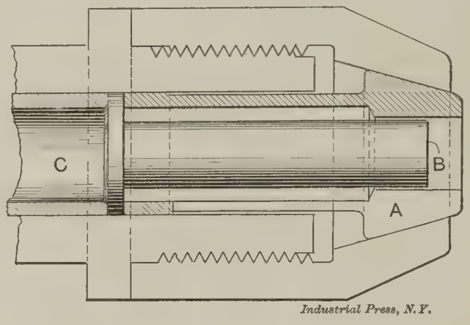
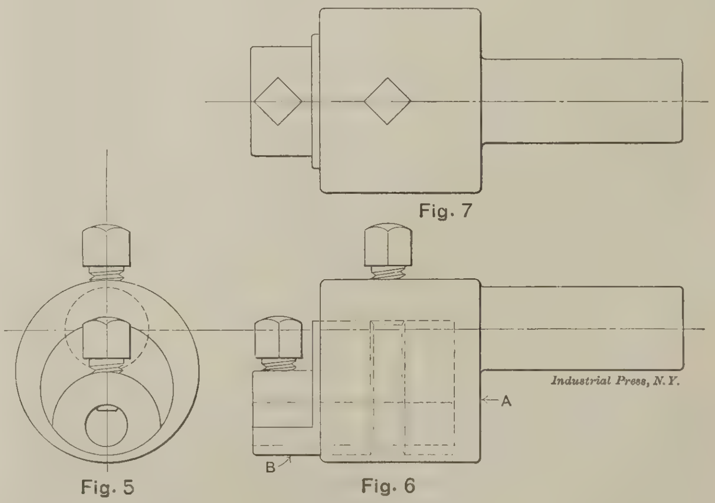


Fig. 4 Chuck for Re-chucking Work.



Eccentric Tool Holder.

Figs. 5, 6 and 7 are the front, side and top views of an eccentric tool holder, that has some points of advantage for use in turret machines, particularly those that have cross feed to the turret carriage, as by its construction the tool may be so set as to obviate the necessity of a long cross movement on some kinds of work that are of large diameter. The shape of the tools may be made to suit the exigencies of the work, that is, they may be plain point tools or bent point tools with the bend in either direction.

As designed the tool consists of a holder *A* with a shank turned eccentric to the body of the holder and in the body a hole is bored eccentric to the body. Through the thickest part of the body a hole is drilled and tapped to receive a setscrew which locks the tool housing *B*, Fig. 6. The tool housing is made to turn freely in the body and has a recess turned in it to receive the impression of the setscrew. The cutting tool which is made of round steel should go easily into the hole, which it will be seen is placed eccentric to the body of the housing. Except for the difficulty of making fine adjustment with this tool, it is otherwise efficient and is quite cheap to make.

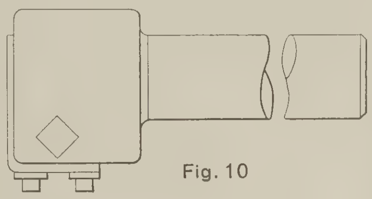
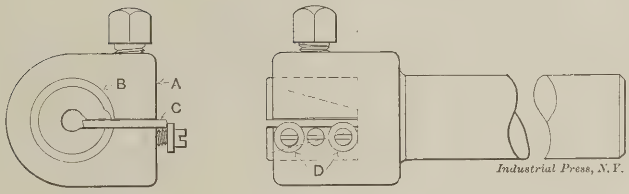


Fig. 10



Industrial Press, N. Y.

Fig. 8

Fig. 9

Chamfer Tool.

Fig. 8 is the front, Fig. 9 the side, and Fig. 10 the top view of a chamfer tool that is useful in truing up and chamfering the ends of castings that are to be turned in a turret lathe; particularly is this so when the turning is to be done by a box tool as the chamfer prepares the work, so that it may receive the steadyrests of the box tool.

The body *A* is bored to receive the hardened steel bushing *B*, and is slotted to take the cutting blade *C*. *C* is held in place by the setscrew and is adjusted to position by the collar screws *D D*, Fig. 9. The steel bushing *B*, Fig. 8, is bored with a taper hole to give the chamfer desired, and is slotted to receive the cutting blade *C*. Provision is made to receive the chips in the bushing by cutting away a portion of its wall.

J. R. Gordon.

Brooklyn, N. Y.

SET OF COUNTERBORES.

Editor Machinery:

The accompanying cut shows a set of counterbores that I designed a number of years ago and which have proved very efficient. The holes for the pilot shanks are lapped to standard plugs so that the pilots will interchange. The pilots are made in all sizes as they are needed, the shanks being made to fit standard rings and the leading ends being hardened and ground.

The rule for cutting the grooves in the counterbores which leaves them fairly strong, is to cut them to a depth equal to one-half the distance from edge of pilot hole to outside of counterbore and to leave fillets of generous radius.

Lawrence, Mass. Fred J. Perry.

COUNTERWEIGHTS FOR MACHINES.

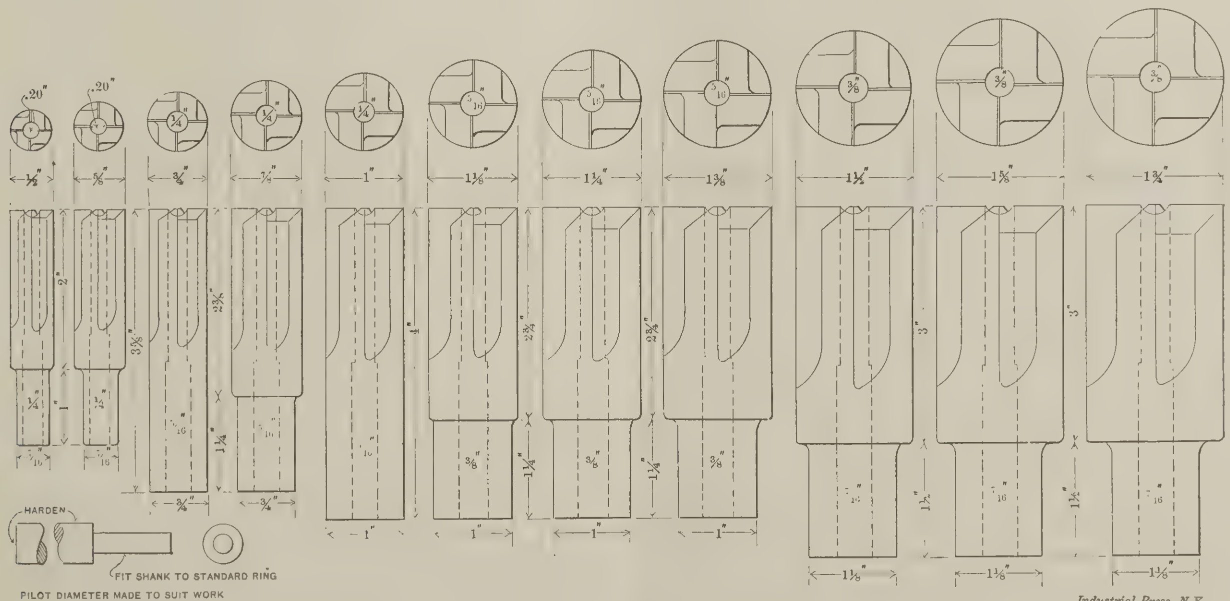
Frank B. Kleinhans.

Editor Machinery:

The counterbalance is an essential part of a great many machines. In some cases the counterweight must be variable and in other cases it must be constant. Some counterweights are for stationary or standing balance only, while others move back and forth in a manner similar to the part which is to be counterbalanced. It is the latter case from which the greatest trouble arises. The counterweight which is used to balance the cutter of a slotting machine or the plunger of a pump are good examples of the case in question.

The counterweight of a punch plunger is subjected to severe treatment. This fact has made itself known in many hundreds of cases. The levers have been broken or bent, and the brackets which form the fulcrum have been knocked off or twisted out of line. A severe shock is evident in every part of the plunger and counterweight when punching large holes with a flat punch. The rupture of the metal occurs suddenly, and thus the resistance of the material disappears in an instant. When this occurs the energy stored up in the spring of the eccentric shaft, frame and various other parts of the machine is released and the plunger snaps down at a very high speed. As the mass of the counterweight is large it cannot accommodate itself quickly to the new speed, and thus we have a severe stress in the counterweight lever. All this is gradually augmented as the connections of the counterweight levers and links gradually wear loose, as there is thus a greater tendency to hammer. It is this hammering effect which more than anything else is responsible for the continual failure of counterweight levers.

The difficulty has been overcome by some builders by the use of springs in place of the usual links. This, of course, reduces the shock as the plunger snaps downward through the



Industrial Press, N. Y.

Set of Counterbores, one-half inch to one and three-quarter inches inclusive.

work, and works very well, but the same thing can be accomplished by making the counterweight levers of steel and large enough so that they will withstand several times more weight than that which is used for the counterbalance.

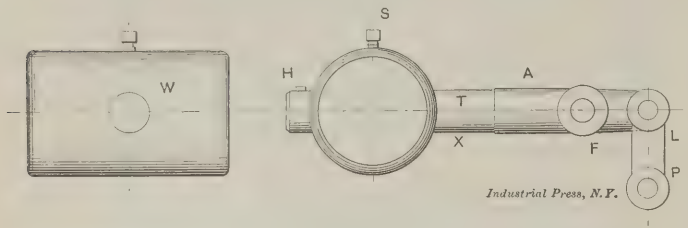


Fig. 1.

Fig. 1 represents a counterbalance with an arm *A* made of a steel casting, and large enough at the fulcrum *F* so as to withstand the bending moment. The links *L* are made of malleable iron and have ample bearing surface for the pins *P*. *W* is the counterweight, and it is convenient in some machines to make this weight adjustable, as, for instance, where heavy special tools are interchangeable on the plunger with very light ones. The arm is then turned off at *T* and the counterweight is bored out so as to form a neat fit. The weight can be clamped on the arm with a setscrew *S*.

There is another cause for the failure of a counterweight. This is owing to the fact that while we may have a perfect standing balance, yet when the machine is in motion the weight and the counterweight will be out of balance due to the difference in velocity at which the two are moving.

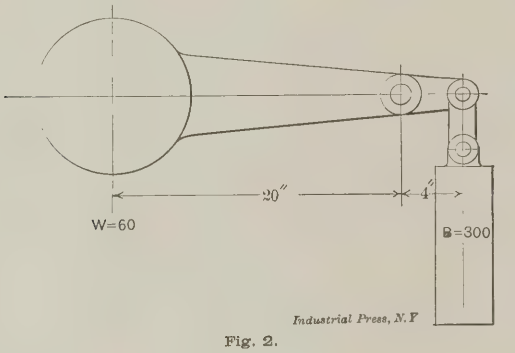


Fig. 2.

Let

E_b = energy of the moving cutter bar.

E_w = energy of the moving counterweight.

B = the weight of the cutter bar.

W = the weight of the counterweight.

V_b = velocity of the cutter bar.

V_w = velocity of the counterweight.

Referring to Fig. 2, in which *W* is the counterweight and *B* is the cutter bar, with the dimensions as shown, we will have

$$E_b = \frac{BV_b^2}{2g} \quad \dots\dots\dots\dots\dots\dots (A)$$

$$E_w = \frac{WV_w^2}{2g} \quad \dots\dots\dots\dots\dots\dots (B)$$

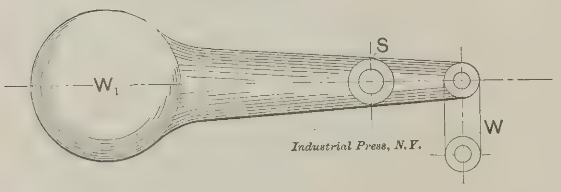


Fig. 3.

or since the velocity of the counterweight and cutter-bar are directly proportional to their arms, we have

$$V_w = 5\,V_b,$$

and substituting in (A) and (B) we obtain

$$E_b = \frac{BV_b^2}{2g} \quad \dots\dots\dots\dots\dots\dots (C)$$

$$E_w = \frac{W\,25\,V_b^2}{2g} \quad \dots\dots\dots\dots\dots (D)$$

also for a standing balance we must have

$$B = 5\,W,$$

substituting in equations (C) and (D) we obtain

$$E_b = \frac{5\,W\,V_b^2}{2g} \quad \dots\dots\dots\dots\dots\dots (E)$$

$$E_w = \frac{W\,25\,V_b^2}{2g} \quad \dots\dots\dots\dots\dots (F)$$

By comparing the equations (E) and (F) we see that the energy of the counterweight is five times as great as that of the cutter-bar. As these masses must be set in motion and again brought to a standstill, the system will be considerably out of balance. When the velocity of the counterweight is low the effect will hardly be noticeable, but when the velocity is great, as will be the case in speeding up a slotting machine, the effect is very marked—so much indeed that quite a number of counterweight levers have been broken.

The style of counterbalance and arm shown in Fig. 3 has been used for the counterbalance of slotting machines. Until very recently these arms have been made as shown in one solid casting and, as there was considerable metal in the weight *W*, the whole thing was made of cast iron. The result was that the arms would snap off at *S*. The way to overcome this difficulty is to make the arms of steel. This can be done by making a solid steel casting of the weight and arm, or by casting the iron weight on the arm or by slipping the weight over the arm through a cored or machined hole. It is better for a slotter counterweight to have the weight fastened securely to the arm so that there is no possible chance for the weight to be thrown off or for the weight to get loose and hammer on the arm. This hammering effect is hard on all of the reciprocating parts of the machine. The links *W* should never be made of cast iron as this material is too uncertain in tension.

When the counterweight is adjustable, as shown in Fig. 1, we can readily shift the weight so as to give a reasonably good balance when the machine is running at a high velocity. It is always best to have the hole in the weight machined, so as to form a snug fit in the arm. In Fig. 1 this is easily done, as both the hole and arm are round. A headless setscrew *H* will prevent the weight being thrown off in case the screws become loose. Frank B. Kleinhans.

TWO SMALL MILLING JOBS.

Editor Machinery:

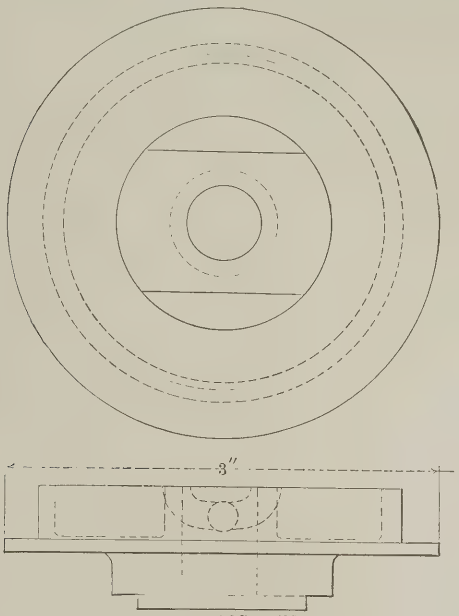
I submit herewith description of a couple of milling operations which I think may prove interesting to some of your readers. In both cases a doubt was expressed as to the possibility of doing the work at a reasonable cost, but when the proper facilities were provided the labor cost in both instances was very small indeed.

In the first instance it was required to mill in opposite sides of a small cast-iron cylinder head two angular slots 3-16 inch wide and about 3-32 inch deep. Two pins in the inside of the cylinder engaged in these slots, thus forming a double bayonet lock which drew the head invariably until the flange came to a bearing against the end of the cylinder. Inside the cylinder was a shaft, one bearing of which was the hole through the center of the head and as this shaft always revolved in the same direction its friction tended to keep the two parts tightly drawn together. At the same time they were easily separated by turning in the reverse direction.

Fig. 1 shows the cylinder head, and Fig. 2 the fixture, or more properly, machine, by which the work was done. Referring to Fig. 2, *A* is the main frame, *B B* the spindles for holding the small end mills and *C* the shaft that carried the piece in which the slots were to be milled. Upon this shaft was secured the cam *D*, in the slot of which the roller *E* traveled.

The cam was made the same diameter as that part of the piece *F* in which the slots were to be made, so the cam slot angles and rises were identical with those to be cut in the work. The wide slot across the end of the piece to be operated on was utilized to hold the work securely in position during the milling operation and at the same time served to locate the slots always in their proper position, which was necessary.

As this work was expected to run into thousands, the machine was made with hardened tool steel spindles running in bronze bushings, the bearings being taper and adjustable for wear. The spindles were hollow and fitted with draw-in collets for holding the end mills which were made from Stubbs steel. There was also a special countershaft which is not shown in the drawing.



Industrial Press, N.Y.

Fig. 1. Small Head in which Slots were Milled.

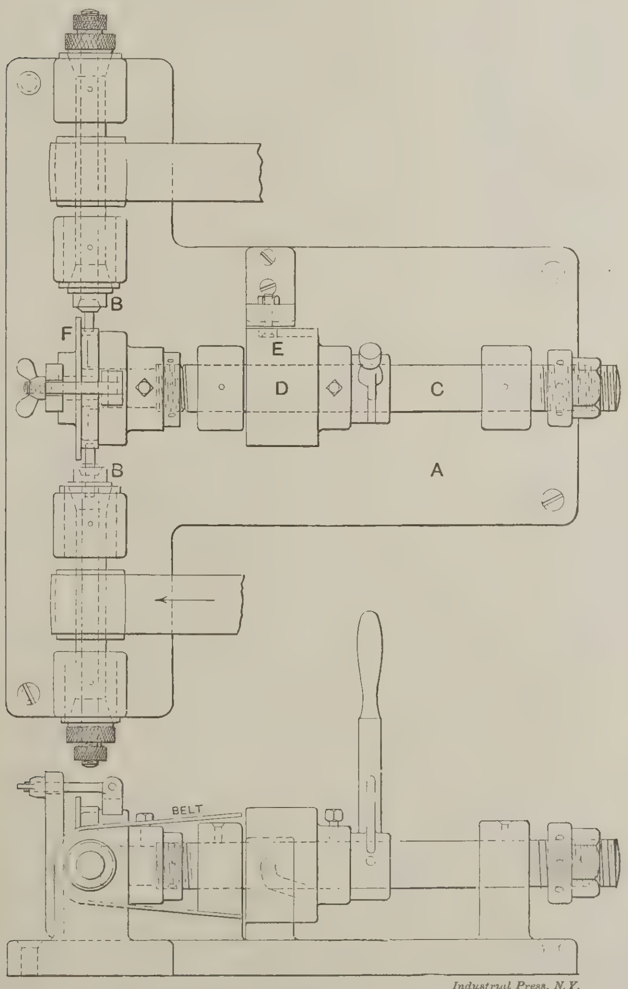


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Fig. 2. The Rig for Milling two Slots at once.

When the operator had secured the work in position, he grasped the handle, first pushing it toward the rear of the machine and then toward the left until the cam stopped against the bracket when the slots were finished. The reverse movement brought the work back to its original position, when it could be removed. The average time required to secure the work in the machine and mill the slots was one-half minute. No trouble whatever was experienced with the end mills. They stood up to the work until worn out.

In the second example the work presents more difficulty, for the mills are smaller and more delicate and the form of tooth is such that the strain in cutting is greater. Added to this the material to be operated on is tool steel instead of cast iron.

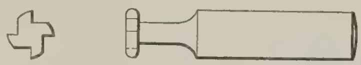
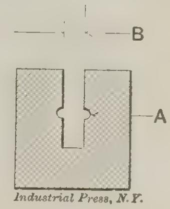


Fig. 3.



Industrial Press, N.Y.

Fig. 4.

Fig. 3 shows one of the mills used for the work, and Fig. 4 a section across one of the pieces to be operated on. There were three sizes of these, the radii of the semicircles at *A* being .025 inch, .0185 inch and .015 inch. Dimension *B*, which determined the size of the shank of the mill, and the "weakest spot," was .075 inch, .051 inch and .046 inch. The length of cut was about 2½ inches.

The work was done on a No. 1 plain milling machine, but not until all the bearings had been cleaned, scraped and tightened until there seemed to be absolutely no shake in the machine. The cone pulley was removed and the driving belt run directly on the spindle and a much larger pulley than usual was used on the line shaft, so that a very high rate of speed was obtained. Occasionally one of the mills would break, but the writer is inclined to attribute this to the fact that the milling machine was so placed that it was subjected to sudden jar transmitted through a springy floor from heavy machinery near by.

The success met with in the above described operations leads him to think that with proper facilities, viz., machinery with practically no lost motion and a sufficiently high speed, these delicate milling operations are no more difficult than those on a larger scale. Waite J. Beverts.

TO ANNEAL SPOTS IN HARDENED STEEL.

Editor Machinery:

Having noticed an article by F. J. K. in the March issue of Machinery, it struck me as a rather queer method to anneal spots on ⅛ inch by 15 inch circular saws (for the purpose of drilling holes) by glazing an emery wheel and creating friction enough to get the desired temperature. While I do not question the fact that the desired result can be obtained in this manner, I think it is not the best way to do it.

Assuming that F. J. K. had ready access to a forge (and what machine shop nowadays has not a forge of some description?), it would have been "dead easy" to take two pieces of, say, 1-inch rod machine steel about 2 feet long and bring the ends thereof up to a white heat. Then, having previously laid the saws on a flat surface of some sort and marked the spots to be annealed with a bit of red lead, hold the heated end onto the spot—a fraction of a minute would do the trick, I assure you. While one rod is being used the other is being heated. The entire dozen saws could in this manner be effectively annealed in a short time. Harry Ash.

Chicago, Ill.

* * *

In the modern industrial railway equipment where turntables are used for out-door work there is a temptation to set the turntables upon too shallow a foundation, the result being that they are thrown out of line by the influence of the frost. In our recent description of the B. F. Sturtevant Foundry there was an illustration of the turntables used, and we are informed that they have withstood the action of frost in a very satisfactory manner. Each turntable rests at the top of a brick circular well with 8-inch walls extending to a depth of 4 feet, or below the frost line. These walls are set upon hard-pan and the center filled with loose stones, providing perfect drainage.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

33. C. W. B.—Could you advise the writer if there is a solution or solder for soldering brass and steel together without rusting?

A.—We submit this question to our readers.

34. R. E.—What is the principle of the "pyrometer" used for measuring high temperatures?

A.—An explanation of the principles that have been employed in the construction of pyrometers would be too lengthy for this department. You are referred to the review of the subject that appeared in the February, 1904, issue, Engineering Edition.

35. G. W. S.—I would like to know how to make the soft solder or composition such as is used in automatic fire sprinklers, which will melt at a low temperature. Can you give me directions for making the same, or is it a secret known only to the makers?

A.—We referred this inquiry to Mr. Everett W. Crosby, General Agent of the North British & Mercantile Insurance Co., New York, who states: "Sprinkler solder is ordinary soft solder—commonly called low test solder—used on these heads, and is composed of the following materials and in approximately the proportions named: Bismuth, 5 parts; cadmium, 1 part; tin, 2 parts; lead, 3 parts.

36. A. F. B.—Are not "pitch" and "lead" the same when applied to screws? For instance, is not an 8-pitch screw the same as one of ⅛-inch lead?

A.—Pitch and lead are in effect the same when applied to single-thread screws only. A single-thread screw of 8 pitch has a lead of ⅛ inch per turn, but a double-thread screw of 8 pitch has a lead of ¼ inch per turn, and a quadruple-thread screw of 4 pitch has a lead of 1 inch. Pitch means the distance, center to center, between adjacent thread sections; lead means the distance between successive turns of the same thread element. That is, in a quadruple thread of say 4 pitch, the distance a nut will travel lengthways of the screw in one turn, is the lead, and in this case, is 1 inch, and it would be the same if it were a sextuple thread. This is shown by the fact that an engine lathe is geared the same for cutting a multiple thread as for a single thread *of the same lead.* The distance between two successive threads is divided into, say, three parts for a triple thread, and this is done by adjusting the tool, or "jumping" the split nut on the leadscrew if it chances to be one-third, one-sixth, etc., the lead of the screw being cut; and not by changing the gearing.

37. R. M. F.—Can you give a good method of tempering small springs, such as gun springs and small flat springs?

Answered by E. R. Markham.

A.—The method pursued when hardening small springs must depend on the equipment of the shop where the work is done. If the equipment includes a hardening furnace, provided with a means of feeding the springs through the fire and dumping them automatically in the oil, well and good. If not, they may be placed in a tube or on a piece of sheet iron bent in the shape of a shovel. These are then heated red hot and dumped in a bath of oil, or tallow. Care must be taken, however, that they do not go in a mass or some of them will harden unevenly or not at all. They must be "sifted" or scattered. Sperm oil, or lard oil, makes a good bath. Tallow will harden, harder than either. A mixture of sperm oil and tallow (equal parts) to which is added a little beeswax, will produce good results when any of the others fail. Resin added to the oil also makes a good hardener; however, sperm oil generally proves all right. When drawing temper, best results follow the use of hot oil, and of a thermometer for gaging the amount of heat, which varies with the steel used and the use to which the springs are to be put, and can be determined only by experiment.

"Flashing" is often used when tempering, and works nicely when practiced by one expert in such practice. The best method for ordinary purposes consists in placing the springs in an iron pan having a long handle and shaking the springs over a fire until heated to the proper temperature. This can be determined by placing a small piece of tallow, or a little lard, or sperm oil, in the pan—just enough to smear the springs. When this catches fire and burns from the internal heat in the springs, dump into a dry box where no current of air can strike them. For some steels this method cannot be used, as the springs would be drawn too low.

38. W. J. H.—Kindly inform me what is the pressure at the point of a turning tool when cutting cast iron. That is to say, suppose we are turning the outside of a 20-inch faceplate, removing ⅛ inch on a side at 1-16 inch feed per revolution, what is the pressure on the point of the tool.

A.—The most complete information on this subject is contained in Flather's "Dynamometers and the Transmission of Power," in which are collected data from many tests upon various kinds of machine tools. Since the introduction of high-speed steel, however, conditions have changed so much that the deductions from the tables mentioned would be to a certain extent incorrect. Probably the most satisfactory way to determine the pressure on a tool is to obtain this from the power required to drive the machine when cutting. Knowing the horse power, if we multiply this by 33,000 we have the foot pounds per minute; dividing this by the cutting speed in feet per minute will give the pressure on the tool, neglecting the power lost in overcoming the frictional or other resistances in the machine itself. In tests upon high-speed cutting steels at the Manchester Municipal School of Technology, to which we shall presently refer, it was found that the power absorbed by the machine varied greatly with the temperature of the bearings and also with the speed. After the bearings become warm, the oil is more viscous, which makes an appreciable difference; and tests also show that it sometimes requires more power to run a lathe at high speed—as would be the case when filing a piece of work—than when taking a heavy cut at a slow speed. These facts indicate the degree of care necessary in arriving at reliable information upon the subject of your inquiry.

Referring to the tests in Flather's text book, we find the following formulas deduced from average results, which give the horse power required to remove a given weight of cast iron, wrought iron or steel:

For cast iron, horse power equals...... $.026 \times W$.
For wrought iron, horse power equals.. $.03 \times W$.
For steel, horse power equals .... $.044 \times W$.

In each of these W is the weight in pounds of the metal removed per hour.

The most complete information upon power required with high-speed steels is that obtained by the English tests at the Manchester Municipal School of Technology. These are very elaborate and cannot easily be summarized, but the following statement of results will answer our purpose and throw some light on the subject:

CUTTING SOFT STEEL.

	Weight per Hour.	Horse Power.
Light cut	105	3
Heavy cut	445	15

CUTTING CAST IRON.

	Weight per Hour.	Horse Power.
Light cut....................	42	1.7
Heavy cut	198	5.5

Applying Flather's formulas to these results we find that for steel the horse power required would be 4.6, instead of 3, for light cutting; and 19.6, instead of 15, for heavy cutting. In the case of cast iron we find the horse power would be 1.1, instead of 1.7, for light cutting; and 5.15, in place of 5.5, for heavy cutting. This would indicate that Flather's formula for steel allows more power for soft steel than was shown to be actually required by the English tests, and will probably give ample power for a considerably harder grade of steel. In the case of cast iron his formula appears to apply very closely, but giving results slightly too small.

From these comparisons it would seem that the rule to multiply the weight of metal removed per hour by .04 would give a safe value for the horse power for both steel and iron.

Further examination of the results of the English tests shows that with the steel more metal was removed per horse power when taking a heavy cut than when running at high speed and taking a light cut; while when cutting cast iron this condition was reversed.

It was found that the cutting force did not vary much with the speed because at high speed the cuts were light while at low speed the cuts were deeper and taken with a heavier feed. The pressure on the tool increased very rapidly as the tool became dull; but when the tool was in good cutting condition the following pressures were recorded:

	Tons.
For soft fluid compressed steel..............	115
For medium fluid compressed steel..........	108
For hard fluid compressed steel	150

	Tons.
For soft cast iron	51
For medium cast iron	84
For hard cast iron	82

It will be noted in reiewing these pressures that those for steel appear to be a little irregular, but they are as recorded in the results of the experiments cited.

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39. E. F. R.—In an article on lining up shafts which I recently saw in an engineers' journal it was stated that a No. 24 standard steel wire was stretched by tension nearly equal to its breaking strength over a trough of water 100 feet long to find the amount of vertical deflection. The sag in the middle was found to be 11-32 inch. It further says that this amount would be doubled in a wire 200 feet long, and halved in one 50 feet long, with the same tension and size of wire. Is it possible to stretch a steel wire so as to have so little deflection in 100 feet, and does the sag vary directly as the length of span?

A.—The sag in a steel wire 100 feet long stretched to nearly its breaking point will depend upon the strength of the steel used in making the wire, and that varies widely. Ordinary crucible steel is rated at 100,000 to 120,000 pounds per square inch of section; plough steel wire, 200,000 to 250,000 pounds; and piano wire, 300,000 to 340,000 pounds. Taking the first value (100,000 pounds) a wire No. 24 (Washburn & Moen) gage should have an ultimate breaking strength of 41.5 pounds. Say that the allowable tension is 40 pounds (which is high), then from the formula:

$$d = \frac{l^2\, w}{8t} \text{ in which}$$

d = dip or sag at middle of span
l = length of span
w = weight of wire per foot of length
t = tension in pounds

we get the equation:

$$d = \frac{10{,}000 \times 1}{8 \times 40 \times 725} = \frac{1}{23} \text{ foot} = .52 \text{ inch dip or sag.}$$

Allowing the ultimate tensile strength of the wire to be 200,000 pounds per square inch of section, the sag of the wire could theoretically be reduced one-half or to .26 inch and so on. But, with the same tension, the dip varies as the square of the length of span. Hence in a span 200 feet long the dip would be four times the above amounts supposing the wire was stretched to the same tension; and or a span of, say, 50 feet, it would be only one-fourth as much.

* * *

MECHANICAL TERMS: A CRITICISM.

Our contributor, Mr. Ridderhof, takes exception to the use of the term "back rest" for "center rest," as applied by Mr. Markham in his article on tool making in the March number. This introduces the interesting question of what determines right and wrong usage in machine shop parlance. The editors think that "center rest" more nearly expresses the object of a support for the outer end of a piece of work held in the chuck of a lathe, when the end is to be bored, reamed or threaded; but at the same time a "back rest" might be said to be a rest for the back or tailstock end as opposed to the headstock end of a lathe, which would be perfectly correct. It is common for a machinist to speak of "back resting" a piece of work, and there must have been good reason for originating this term, so frequently used.

We have examined the works of several writers, and find, for example, that Prof. Van Dervoort, in his book on shop practice, uses center rest and steady rest as synonymous, and follow rest to indicate the support attached to the back of the lathe carriage, but does not employ the term back rest. On the other hand, Pratt & Whitney, in their catalogue, use the term back rest to the exclusion of center rest. In the Brown & Sharpe treatise on grinding, center rest and follow rest are applied as usual and back rest is employed for a support placed back of the work opposite to the wheel, but which remains stationary and does not travel with the table. Mr. Ridderhof, in his letter, also makes the following remarks:

"I have little inclination to criticise Mr. Markham's work, as I have in the past read much of it with pleasure and profit, but I would like to call attention to a few statements by which I believe the young fellows, for whom the article in question was evidently written, are almost bound to be misled.

"Mr. Markham, antagonistic to our endeavors to make the boys leave the file alone, advises filing the pilot and shank of a counterbore to size. This is a little too much; and why, in milling the flats on the body of this tool with a "shank" (end) mill it should be necessary to notice the reading of the graduated dial I do not understand. The work is fed vertically past the mill and clearly no vertical setting is required.

"But of more importance than this is the lapping of the body of a counterbore and taking care to measure this only at a temperature of about 70 degrees. Where, oh where, is a counterbore used that needs to be so accurate? I've never worked at anything finer than watches, nor much rougher than windmills, but within that range no problem of lapping a counterbore and the consideration of its expansion and contraction at different temperatures has ever presented itself. If a difference of a few degrees would introduce inadmissible inaccuracies, what are we going to do when our counterbore heats up to 180 degrees in ordinary use? Are we to experiment with it and find at what rate of speed and feed it will attain a certain temperature and then lap it at that temperature so as not to spoil our work? I would much appreciate it and I'm sure my fellow readers would also like to have Mr. Markham explain how he overcomes or compensates for this rise in temperature and consequent expansion which is bound to accompany their actual use. Perhaps they are made for show case use.

"I hope Mr. Markham will accept the above blunt criticism as written by one who has learned much from him on the subject of hardening and tempering, one who writes with reluctance but cannot permit what he believes to be important errors to pass uncriticised in a journal devoted to, and exceedingly successful in helping mechanics of all grades to a better understanding of their trade."

This letter was submitted to Mr. Markham, who writes:

As to the term "back rest" I will explain that as a boy and apprentice I was taught to use the term "center rest," but as I was brought in contact with skilled mechanics I found the majority used "back rest," as Joshua Rose's "Machine Shop Practice." Dictionary of Machine Shop Terms, under "steady rest" or "back rest," defines it as a device for steadying work in the lathe. It is often so used by writers on machine shop subjects and in fact I have seen it oftener than either steady or center rest. I feel that the young man should become familiar with all the different terms as applied to parts of machines.

As to the use of the file, and the advisability of discarding it, I find a tendency in most shops to do away with its use where practical, but to want the operator more skillful in its use than ever before when necessary. If Mr. Ridderhof is not teaching his apprentices to be skillful filers I am sorry for them. The book on tool making, published by the International Correspondence Schools, which I consider the best thing on the market, describes the use of a file on counterbores and also uses "steady rest" and "back rest" to designate the same thing.

In the matter of using water of about a certain temperature when cooling pieces being lapped, our friend must know the danger of gaging work when hot which when cool would be smaller; and as to the necessity of keeping the water at exactly 70 degrees, such expressions are not meant to be taken altogether literally. A certain temperature must be given, and as gage lapping requires approximately a certain temperature for measurements to insure passable results, it is always considered safer to err on the safe side. I would say just a word; I don't think Mr. Ridderhof would use a lapped counterbore—which is an unusual thing—on a job when it was to be heated to 180 degrees. The statement in the article would free one's mind of the thought that it was often necessary to lap a tool of this kind, but when it is necessary the young man should know how to do it.

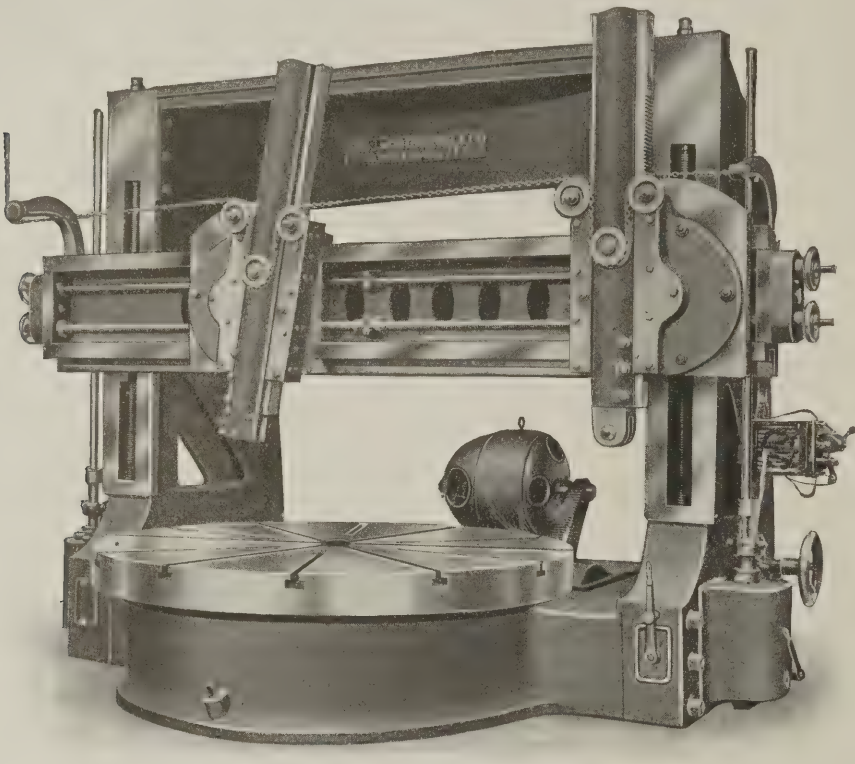
E. R. Markham.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

POOLE MOTOR-DRIVEN BORING MILL.

In our October, 1903, number we illustrated a new boring mill that had been brought out by the J. Morton Poole Co., Wilmington, Del. This mill had several features of distinction, the most prominent of which was a worm-driven table in place of the usual spur driven table. The illustration herewith shows their late type of this mill, equipped with electric motor, which provides for a speed reduction of 50 per cent. which, in connection with the back-gear ratios of 12, 36, 95 and 285 provided in the mill, enables the operator to obtain any desired table speed between ½ and 24 revolutions without stopping the mill. Any make of motor, or system of speed control, can be used with equal advantage.



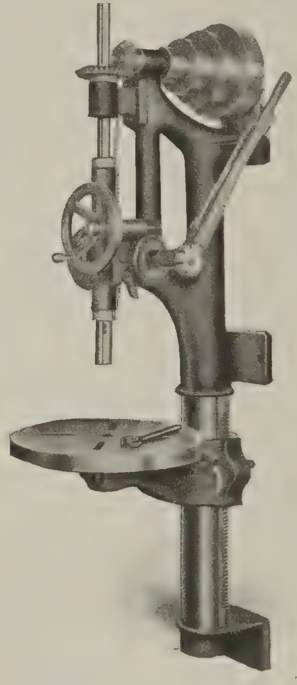
Poole Motor-driven Boring Mill.

The rapid traversing shaft for crossheads and tool bars is driven from the back gear shaft in the bed by means of a silent chain. The usual handwheels on the crossheads are omitted, as the tool bars are raised and lowered by power. For close adjustment of tools the operator places the crank handle on the upper rod; the absence of these hand wheels and all overhead cross-rail elevating mechanism, the inclosing of all gears to protect them from dirt and accident, the location of the cone pulley or motor on the bed between the uprights, and the small number and convenient location of operating levers and hand wheels, as well as the great driving power and rigidity possessed by the mill, make it a tool which is fully up to modern machine shop practice in every particular.

IMPROVED POST DRILL PRESS.

An improved post or wall drill press recently brought out by Boynton & Plummer, Worcester, Mass,, is shown herewith. The drill is designed to be fastened to the wall or post by brackets, which are cast on the upright column for this purpose, thereby taking up much less room than the ordinary floor drill, yet containing all of the features of the floor drill. It has a swing of 24 inches and the spindle, which is counterbalanced by weight in the upright column, has a vertical traverse of 11½ inches and is bored with a No. 3 Morse taper socket. The table can be swung around the upright column at any angle and has a vertical traverse of 18 inches operated by rack and pinion. The greatest distance between spindle and table is 24 inches, which allows work of large dimension to be handled.

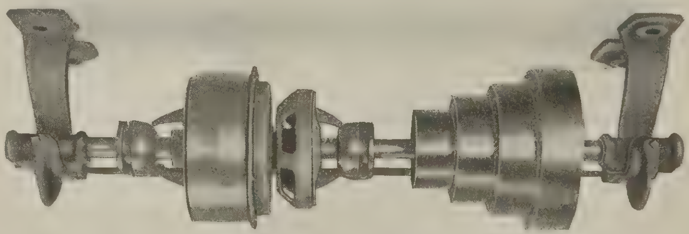
The machine is equipped with both lever and screw feed, which can be changed instantly from one to the other by a small lever that throws the feed worm in or out of mesh with the worm gear. The lever is arranged with a notched ratchet by which the entire traverse of spindle can be operated with the lever always at a convenient point or angle. This drill has a 4-step cone pulley of the following dimensions: 11 inches, 8¾ inches, 6¼ inches, and 4 inches for 2¾ inch belt and is furnished with countershaft to match. Driving pulleys on countershaft are 10 inches for a 3-inch belt and should be run at 230 revolutions per minute. The entire length of drill is 72 inches; weight, 610 pounds.



Post or Wall Drill Press.

SMITH ONE-BELT REVERSING COUNTERSHAFT.

A one-belt reversing countershaft is illustrated herewith, as manufactured by the Smith Countershaft Co., Melrose, Mass. In the detail engraving pulley *G* is the driving pulley on which the single belt runs and this pulley is made to operate the countershaft either in a backward or forward direction by means of two friction clutches and a train of gearing. The pulley is loose on the shaft but can be rigidly connected with the shaft by means of the friction clutch *K*, shown at the right, which causes the shaft to revolve in the same direction as the pulley. This clutch is of the conical-shaped type, and is thrown in or out by means of the spool which forces apart the fingers and draws the two clutch surfaces together. The conical part of this clutch is keyed to the shaft. For obtaining the reverse motion there are three rawhide pinions



Reversing Countershaft.

—of which one is shown at *M*—which mesh with internal teeth cut on the inner surface of pulley *G*, and also with external teeth on the outer surface of the gear *F*, which latter is keyed to the shaft. The three rawhide pinions are supported by a three-armed spider, *D*, which has a long hub to which is threaded the friction clutch *A* at the extreme left end. When the pulley and shaft are turning together gear *F*, of course, turns with them, and the rawhide pinions, as well as the spider *D*, also revolve, these several parts rotating as one body. If, however, the clutch *K* which locks the pulley with the shaft were disconnected, and the spider *D* which carries the rawhide pinions were compelled to remain stationary, it is evident that the pinions would then act as intermediate pinions, causing a reversal of the motion between pulley *G* and gear *F*, thus making the shaft rotate in a direction opposite to that in which the pulley is turning. This is accomplished by means of the clutch shown at the left, which locks cone *A* with the conical-shaped casting *B*. Casting *B* is prevented from turning at all times by means of a projecting arm, *E*, and hence when clutch is thrown in, the spider *D*, which carries the rawhide pinions is held rigidly in one position. The two spools for working these two clutches are under the control of a single shifting lever, and when the lever is moved in one direction it disconnects one clutch and throws in the other one, while if moved in the opposite direction it disconnects the latter clutch and throws in the former, thus reversing the motion of the countershaft. If the shifter is left in the middle position both clutches will be disconnected and the pulley will be rotated loosely on its shaft while the shaft itself remains stationary. Several details of construction of this countershaft have been ingeniously worked out, such as the means for oiling the spring pins for forcing apart the clutches, so as to avoid sticking of the surfaces and the flange *C* which forms the outer bearing, as it were, for the pulley, to compensate for the part of the pulley hub that is cut away where the gear *F* comes. The advantage claimed for a countershaft of this description is that the belt pull is always in one direction, so that with a reversal of load there will be no flapping of the belt. The countershaft has been thoroughly tested and is said to show no appreciable wear, while the rawhide pinions produce quiet running.

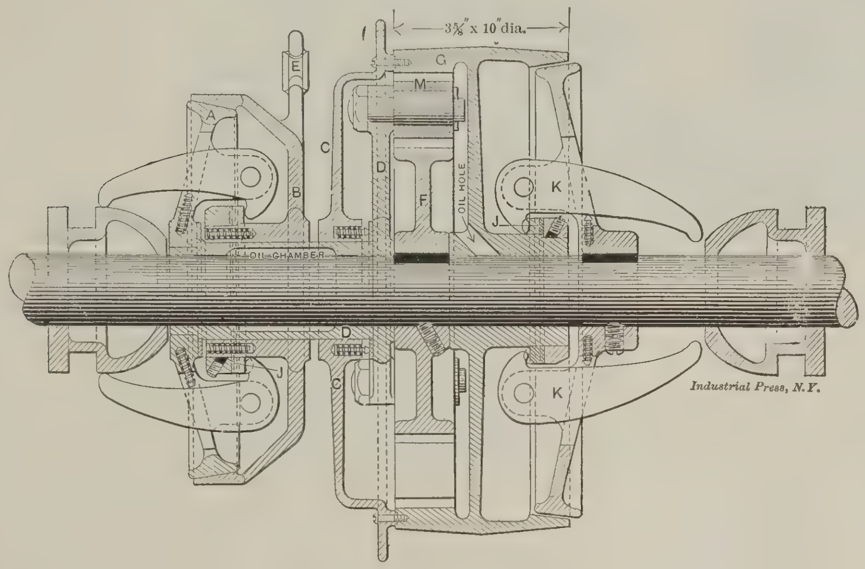


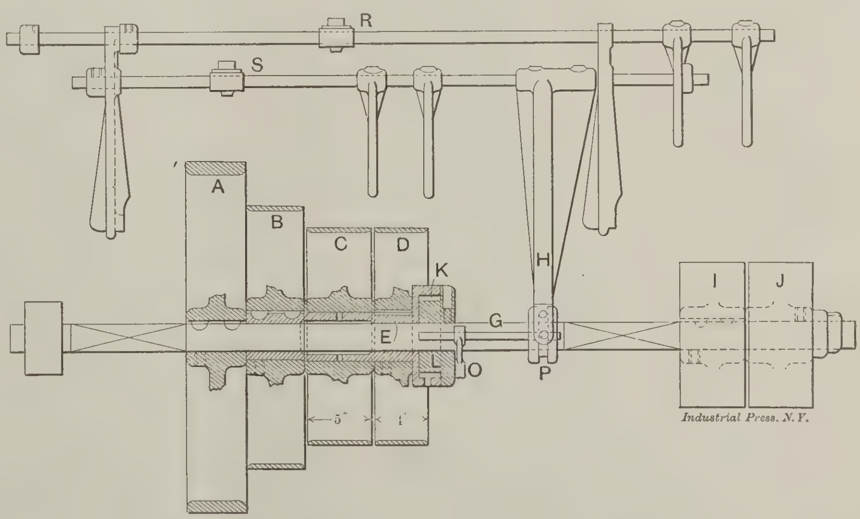
Fig. 2. Details of Countershaft.

TWO-SPEED COUNTERSHAFT.

A new two-speed countershaft has been brought out and patented by the Cincinnati Planer Co., Cincinnati, O., which is now supplied with their planers at a slight additional cost. On the countershaft there are two pulleys for the planer belts, one of small diameter for the cutting stroke and one of large diameter for the return. There are also two pairs of tight and loose pulleys, by means of which the countershaft is driven at different speeds through a belted connection. In the illustration, *A* is the large pulley for driving the planer during the return of the platen. This pulley is connected to the shaft and is always driven by the tight pulley *I*. Pulley *B*, however, which drives the planer during the cutting stroke is not keyed to the shaft, but instead is attached to a long sleeve which can turn freely upon the shaft. Upon this sleeve are also the tight and loose pulleys, *C* and *D*, and the speed at which *B* rotates, and consequently drives the planer, depends upon whether sleeve *E* is driven by pulley *I* or by pulley *D*. If it is to be driven by *I* the sleeve must be connected with the shaft, which is accomplished by means of a friction clutch; if it is to be driven by *D* the friction clutch must be thrown out so that the sleeve will be free to turn upon the shaft.

There are two shifter rods, *R* and *S*, shown in the upper part of the engraving, for manipulating the countershaft. The upper one carries a fork for shifting the belt upon pulleys *I* and *J*. The other one shifts the belt upon pulleys *C* and *D*, and also operates the friction clutch by means of the lever *H*. The clutch is located within a recess at the end of the bushing *E*. It consists of a hub *L*, keyed to the shaft, between which and the inner surface of the recess is a split ring *K*. The ends of this ring are forced out by an eccentric pin which can be rotated slowly by means of the lever *O*. This lever in turn receives its motion from a sliding feather attached to the spool *P*.

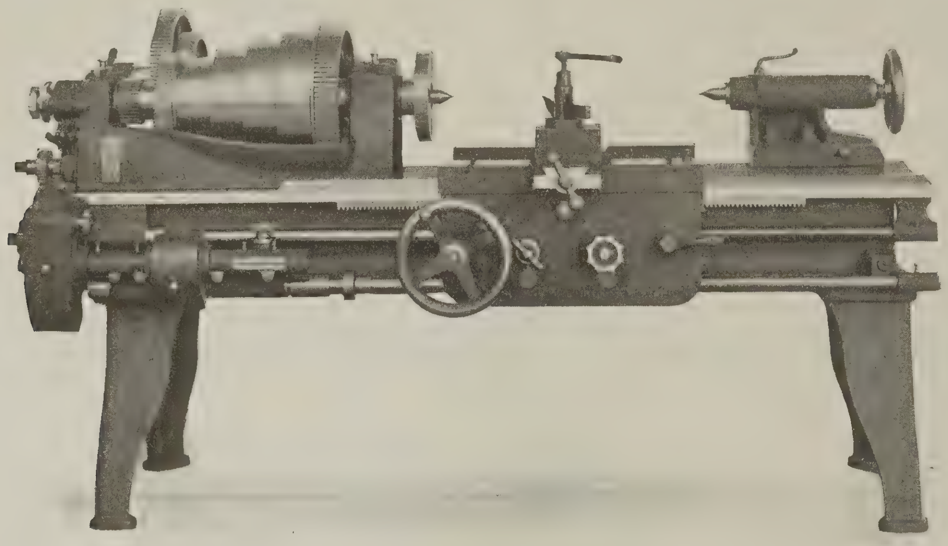
It will be seen that the shifter rod *R* need be used only for starting up the high-speed return pulley *A*, and that the two cutting speeds are obtained entirely by means of the single shifting rod *S*. Supposing the belt to be running on the loose pulley *C* the movement of the shifter toward the right will first disconnect the clutch and then shift the belt on to the tight pulley *D*, whence *B* and *D* will turn together. Then a movement of the shifter to the left will first shift the belt to the loose pulley, stopping the motion of pulley *B*, and then throw in the clutch, causing *B* to start again under the influence of pulley *I*, which will drive it at a slower speed.



New Countershaft of the Cincinnati Planer Company.

LATHE FOR HIGH-SPEED STEELS.

The cut on next page shows an 18-inch engine lathe designed for use with high-speed cutting steels, that has recently been placed on the market by the F. E. Reed Co., Worcester, Mass. This lathe is a pioneer in its line, from the fact that it is designed with ample power for turning work up to the full swing of the lathe with the best high-speed steels. Heretofore, so far as we know, the high-speed lathes have been designed for turning smaller diameters only. The builders write us that this lathe has more power in the head and more strength in the feed works than any of the high-speed cutting steels will stand when cutting to the limit of their endurance. In other words, the lathe is ahead of the steels, and is capable of doing a larger range of work, and more of it, in a given time, than the tool will stand.



Reed Lathe for Turning up to 18 inches Diameter with High-speed Steels.

This lathe swings 18 inches over the bed and with 8-foot bed takes 3 feet 6 inches between centers. It weighs 3,470 pounds. The head spindle has a front bearing 3⅝ inches diameter by 7½ inches long. The cut shows the lathe with a four-section cone pulley, the largest section being 15 inches diameter for 3½-inch belt, with a small ratio and a large ratio of back gears. With open belt and small ratio of gears, iron or steel may be turned, up to 5 inches diameter, cutting as many feet per minute as the best high-speed steels will stand. The lathe also has power enough to take any depth of cut, and any feed desired from 40 cuts to 8 cuts per inch. With the large ratio of back gears any work can be done in the lathe from 5 inches diameter up to the full swing of the lathe, in either cast iron or steel. The diameter of the cone pulley and the ratio of gearing are so made that the lathe has a regular gradation of spindle revolutions per minute, from 400 to 10. This is ample range for turning any diameter up to the full swing of the lathe, at any cutting speed desired.

The rest is extra heavy and has a bearing on the bed its entire length, or 36¾ inches, and is stiff enough to stand any strain required of it. The feed works are amply strong in proportion to the rest of the lathe. The vees on which the rest slides have more than twice the wearing surface of the ordinary lathe of this swing. Cutting tools may be used as large as ¾ inch x 1¼ inches.

This lathe may be furnished with pan, pump and piping, if desired, for flooding the cutting tools with water or other lubricant.

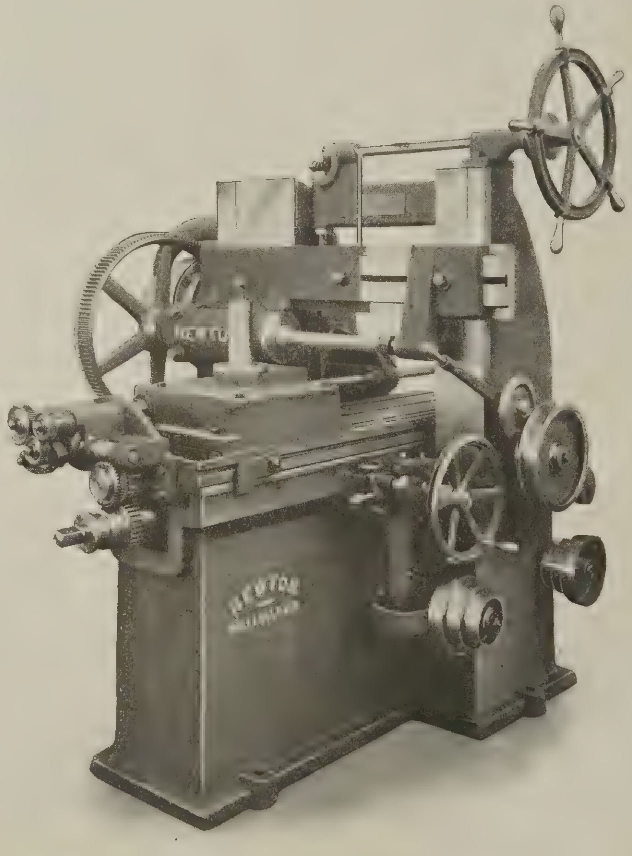
NEWTON WORMWHEEL CUTTER.

The cut herewith illustrates a new plain milling machine manufactured by the Newton Machine Tool Works, Philadelphia, Pa., arranged as an automatic wormwheel cutting machine. The table is 6 feet 6 inches long, giving the machine a capacity for wormwheels up to 48 inches in diameter, and the machine will swing a cutter up to 7 inches in diameter. The spindle which drives the worm wheel is 2 11-16 inches in diameter and is revolved by an accurately cut wormwheel and worm of steep lead through change gearing which mesh directly into the driving gear. The feed motion to the table, when the machine is being used for cutting wormwheels, is obtained from the dividing shaft by gearing, and acts directly on the feed screw through a clutch which is clearly shown on the end of the machine.

The machine is also well adapted for cutting the Hindley type of worms and wormwheels. The worm to be cut is placed on the cutter arbor, and the cutter on the vertical spindle of the dividing box.

When it is desired to use the machine for milling it is only necessary to remove the dividing box and shaft which are shown clamped to table.

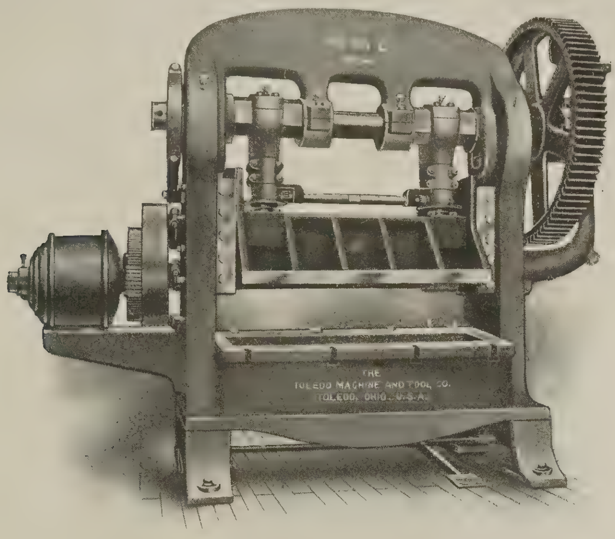
For milling, the machine has six changes of automatic feed and power quick return, as shown in the half-tone, and will mill work up to 6 feet in length. The table of the machine is 16 inches wide and 6 feet 6 inches long, and the uprights will admit work 20 inches wide.



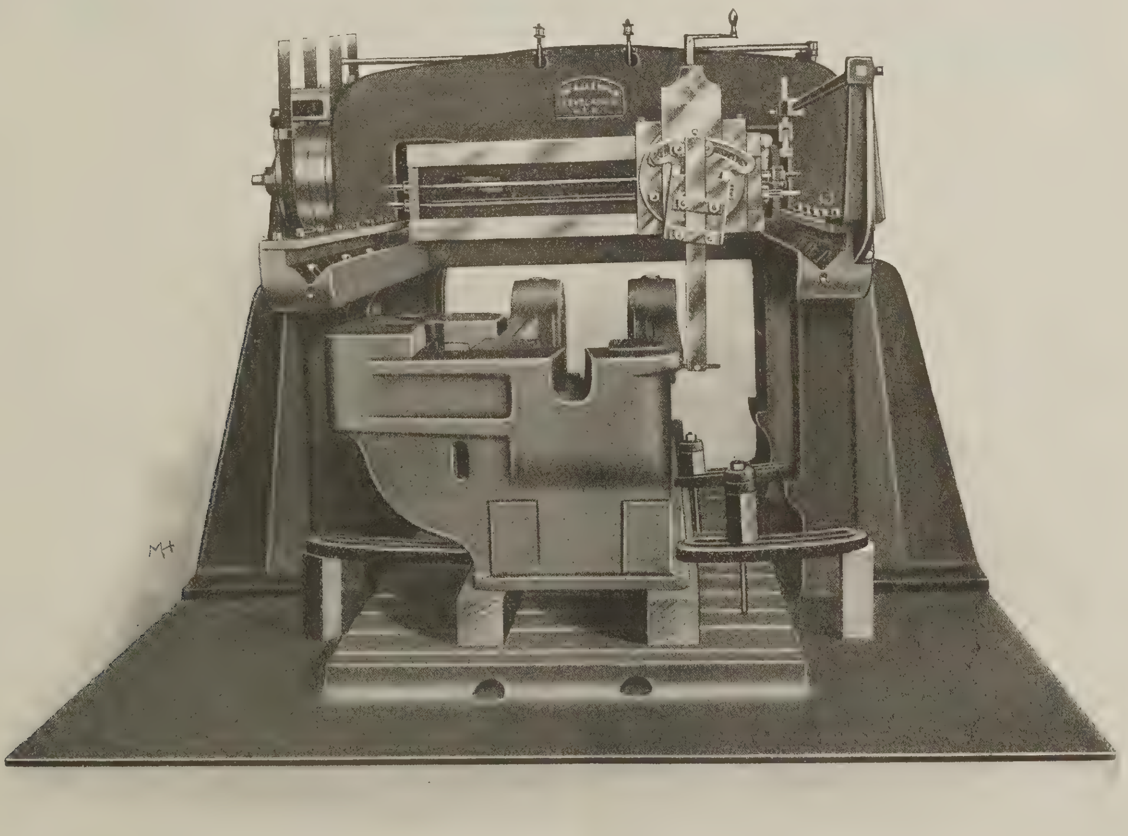
Newton Wormwheel Cutter.

TOLEDO POWER PRESS.

One of the new types of motor-driven crank power presses is shown in the accompanying cut. This machine weighs about 40,000 pounds and will exert a pressure of 500 tons, yet motor connection is such that less than 4 horse power is required to operate the press. The slide bearings are of special design, and the slide adjustment is unusually long and provided with a new clamping device on the pitman screws. The clamp is provided with a cap and four studs which lock the adjustment. Bevel gear connection between the two pitman screws is used for adjusting the slide to various heights. The manufacturers attribute the small amount of power required for operating this press to the style of clutch used, which is of a gravity releasing type and gives unusually satisfactory results. The pattern for this press, with modifications in bed area, width, height, etc., can be made to suit special requirements. An automatic knock-out in the slide and automatic cam-actuated knock-out in the bed may be fitted to the press, if desired. Several sizes of this type of machine, equipped with motor drive, are manufactured.


THE
TOLEDO MACHINE AND TOOL CO.
TOLEDO, OHIO, U.S.A.

Electrically-driven Power Press.



Special Planer for Heavy Work.

HEAVY PLANER OF NEW DESIGN.

The Ajax Mfg. Co., Cleveland, O., have developed, as a result of the needs of their business, a special type of planing machine designed for heavy work which they have now placed on the market in sizes ranging from 48 inches to 144 inches in width and of any desired length and height. The design of this planer is clearly indicated by the engravings on this and the next page. Unlike the usual type of planer the work in this case remains stationary and the tool travels. The casting to be planed is bolted to a massive bedplate and a wide slide carries the cross-rail planer head and tool back and forth over the work, the design of the slide being in effect an extension of the principle used in the operation of the ram of a shaper. The slide in this case is carried by V-guides supported by uprights which are bolted to the bedplate, and these uprights are stiffened by an arch-shaped casting of box section passing up over the slide and connecting the main upright of one side with the corresponding upright on the other side. Obviously, with a planer of this type the cross rail cannot be fed down to the work, and consequently where castings of different heights are to be machined they must either be blocked up on the bedplate or else, if the variation in height is not great, dependence must be placed upon the use of tool bars of different lengths. It is this feature which constitutes the special nature of the tool and makes it less easily adapted to work of varying heights than a standard type planer. On the other hand it has certain features of its own which make it a particularly useful machine in every way, especially where a large quantity of a certain class of work is to be turned out. Inasmuch as the slide or ram weighs considerably less than the table of an ordinary planer together with the casting being machined, it is possible to secure an unusually quick travel, reverse and return. In other words, the slide can be handled with great facility at a high rate of cutting speed. In the machine shown the speed of the cutting tool is 40 feet per minute, the speed of the belt on the cutting stroke is 1,019 feet per minute, and the return 45 feet per minute with a belt speed of 1,148 feet. The slide is driven by a gear running in a rack on top of the slide, the rack being 8½ inches wide and 2½ inches diametral pitch. The width of the driving belt is 3 inches and the maximum feed up and down is ⅛ inch, with side feed of ¼ inch, though this, of course, can be varied as desired. At a cutting speed of 40 feet per minute the planer can be reversed in a travel of less than 1 inch.

In Fig. 1 the planer is shown operating on a casting placed at the extreme end of the vees, and it will be evident that by locating the work in this position and allowing the ram to over-travel, pieces of any width can be machined which would not pass between the uprights of a standard planer of corresponding size. We are informed that it is the intention of the builders to supply this machine in sizes to suit the special work that a firm may have to be done, and their experience with the original machine built for their own plant is that it is very satisfactory for work of such character.

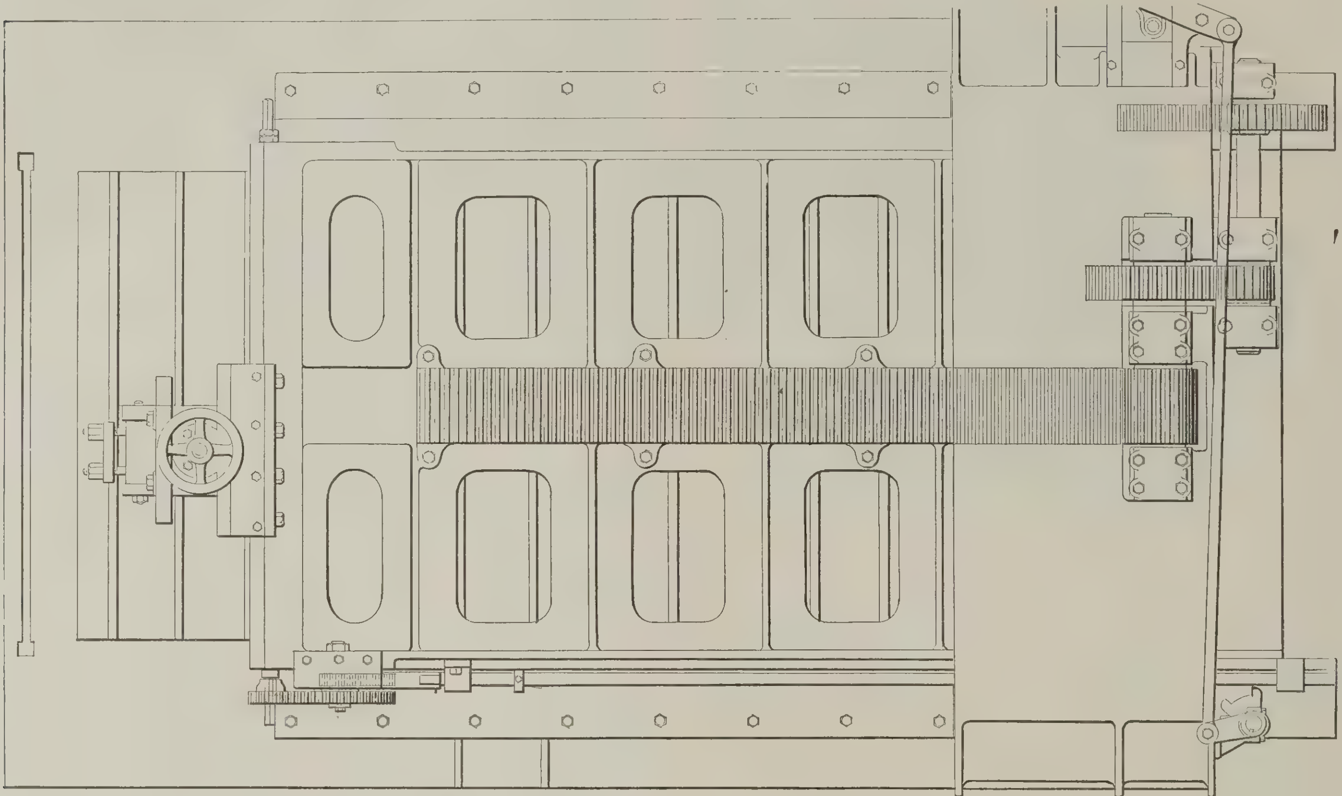

Industrial Press, N.Y.

Fig. 2. Plan, showing Top of Slide and Rack Drive of Ajax Planer.

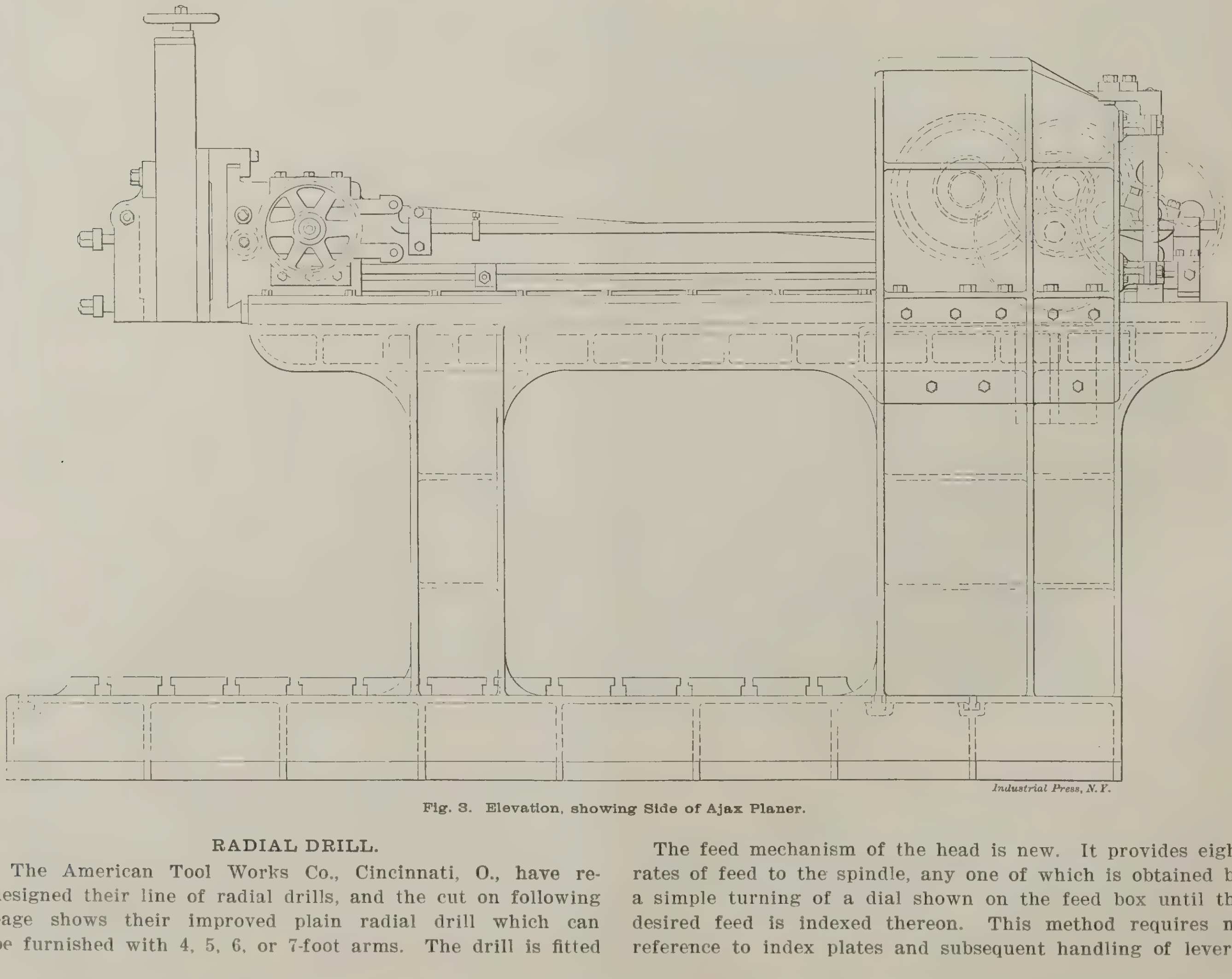

Industrial Press, N.Y.

Fig. 3. Elevation, showing Side of Ajax Planer.

RADIAL DRILL.

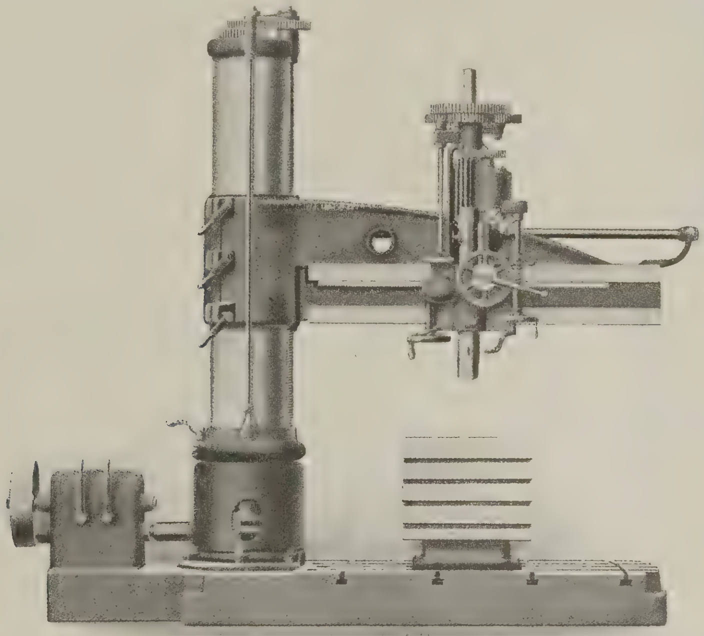
The American Tool Works Co., Cincinnati, O., have redesigned their line of radial drills, and the cut on following page shows their improved plain radial drill which can be furnished with 4, 5, 6, or 7-foot arms. The drill is fitted with a speed box of geared friction type, giving four changes of speed, and operated by use of two levers. The frictions are of the double-band type, having few parts in their construction. The speed box can be easily interchanged with a cone by simply breaking a coupling connection on the lower driving shaft of the machine.

The feed mechanism of the head is new. It provides eight rates of feed to the spindle, any one of which is obtained by a simple turning of a dial shown on the feed box until the desired feed is indexed thereon. This method requires no reference to index plates and subsequent handling of levers.

The feeds operate through a friction device which permits a drill to be crowded without straining the feed works. A plate is provided indicating twist drill sizes, and this in connection with the dial index, enables the operator to secure the proper feed for the drill he is using. The spindle is provided with trip mechanism.

There are sixteen changes of speed at the spindle—all available without stopping the machine. The column is of double tubular type, the inner column extending the entire height, and has full bearing for the outer column at both top and bottom. The arm is so designed as to have its under side parallel with the base.

A tapping mechanism is carried on the head, between the back gears and the speed box, thus placing the back-gear speed reduction between the friction drive and the tap, so as to provide ample power for heavy tapping. The taps are backed out at an accelerated speed. The lever for starting, stopping or reversing the spindle is at the head, and is controlled from the front.

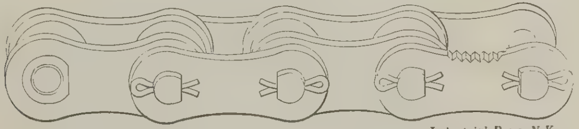


Radial Drill with Speed Box.

WHITNEY DETACHABLE ROLLER CHAIN.

A new detachable roller chain for power transmission, especially on automobiles, has been brought out by the Whitney Mfg. Co., Hartford, Conn., and is shown in the accompanying illustration.

The links on one side of the chain are fitted tightly on the rivets and they are permanently secured by rivet heads in the same manner that links are held in ordinary riveted chains. All of the links on the opposite side of the chain are detachable and they are locked in position by cotter pins set parallel with the long diameter of the link. These detachable links are fitted tightly on the rivets with exception of one, which is called the connecting link, and this has notches in the top surface to distinguish it from the others. This special connecting link may be removed by the fingers after the cotter pins have been withdrawn.

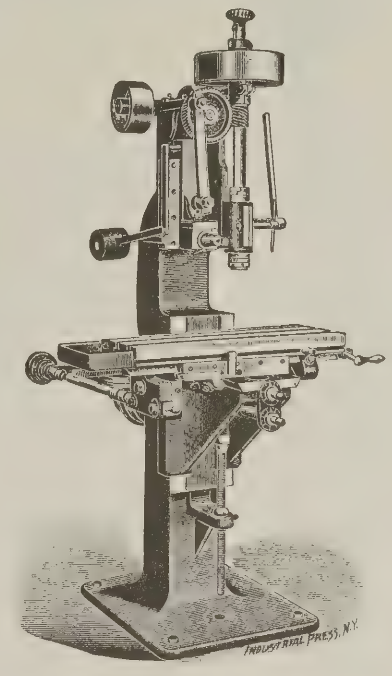


Industrial Press, N.Y.

The advantages claimed for this combination are therefore as follows: The cotter pins set parallel with the long diameter of the link instead of at right angles, are out of the way, even though they may be longer than necessary. All of the detachable links, except the special notched connecting link, are forced tightly onto the rivets, and are therefore practically as secure as the links on the opposite or riveted side of the chain. The rivet heads on the riveted side of the chain do not project far beyond the surface of the side plates, and the chain can therefore be used on certain automobiles and machines where there is little space for chain clearance. The rivets are flattened on one side, where they pass through the side plates, and so cannot turn in the side plates. The chain is so extremely simple that it may easily be understood by any operator without an explanation.

MILLING MACHINE AND SLOTTER.

A vertical milling machine with slotting attachment has been brought out by R. M. Clough, Tolland, Conn. The table is 28 inches long, 9¾ inches wide, and has a longitudinal feed of 21 inches, a cross feed of 9 inches and a vertical feed of 15 inches. The cross and vertical screws have graduated dials. The spindle has a taper bearing 7 inches long at its lower end and is 1⅞ inches in diameter. Driving pulleys of 8 or 10 inches in diameter, with 2¾-inch belt, are furnished.



Vertical Milling Machine with Slotting Attachment.

The slotting attachment is bolted to the side of the head and also to the top of the machine. The slide is 12 inches long, running in bearings 10 inches long, and has a stroke of 4¾ inches. The slide is driven by a hardened tool-steel worm running in a bronze gear, and can be set to plane at an angle of 5 degrees or less in either direction, if desired. The gear can be thrown in or out of mesh with the worm by a movement of the lever. The tool post of the slotting attachment will take a tool ⅝ inch by 1 inch, and has a relief motion on the up stroke. The tool post can be swiveled so as to cut either lengthwise or cross-wise of the table. The slide is balanced by a movable weight.

ATTACHMENT FOR MONITOR LATHES.

The construction of the Cahill lathe, made by P. J. Cahill, Leeds, Mass., and shown in Fig. 1, is such that it is unnecessary to stop the spindle to remove or insert the work. The features of the lathe are the style of chucks used for holding work and the method of opening and closing the jaws while the spindle is in motion.

Fig. 2 is an outline drawing of one of the chucks. It consists of an inner shell *B*, slotted at one end to receive the jaws *A*, and bored out and threaded at the other end to fit the nose of the lathe spindle. Outside of this inner shell *B* is an outer shell *C*, held in place on the inner shell by the nut *D*. The jaws are always held in the same position longitudinally by means of a bar *E* which screws to a bar extending through the lathe spindle, and is held at the rear end against a fixed stop. The advantage of this is obvious; it makes possible the use of cross-motion cutters and stops which would otherwise be almost useless owing to the variation in the size of castings which would bring the jaws in different positions at different times.

The jaws are opened or closed by an endwise motion of the lathe spindle which slides the outer shell *C* longitudinally—the jaws, as stated, remaining in a fixed position. The mechanism by which these results are accomplished will be clear from Fig. 3. The lathe is of the usual monitor type, except that there is a shelf extending to the rear of the headstock, on which is the sliding bracket *L* provided with a bearing at its upper end, for the reception of bar *E*, which extends through the hollow lathe spindle and connects with the jaws of the chuck.

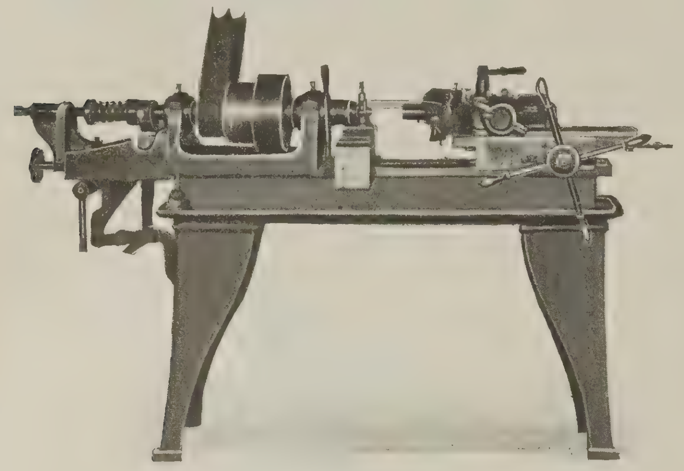
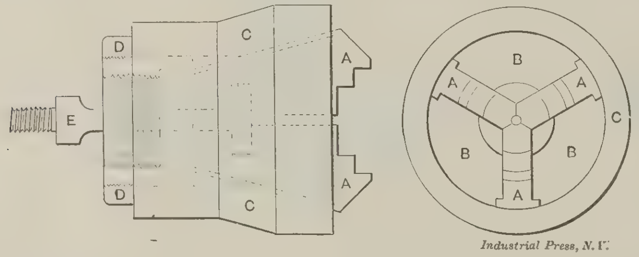


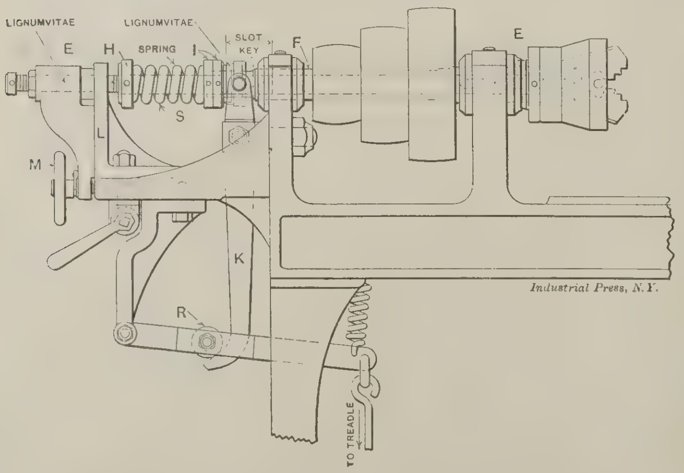
Fig. 1. Monitor Lathe with Cahill Attachment



Industrial Press, N.Y.

Fig. 2 Chuck of Cahill Lathe.

The operation of the chuck is dependent upon the spring *S*. This bears at one end against the nut *H* on bar *E*, and at the other end against nuts *I I* on the projecting end of the lathe spindle. The spring, therefore, tends to force the nuts *I I* and the nut *H* apart, causing bar *E* to bear against a lignum vitæ step bearing in bracket *L*, and the spindle to be forced forward so that the outer shell of the chuck will tend to close the jaws. By means of handwheel *M* the location of the step bearing can be changed, and as this also determines the position of the chuck jaws, the adjustment of handwheel *M* will cause the jaws to open a greater or less amount, as required. The tension of spring *S* can be adjusted so that the pressure of the jaws may be made as light as desired, or as great as 4,000 pounds. A treadle is used to open the jaws by the connection shown, consisting of lever *K*, which is connected by a cam roll *R* attached to a lever connecting with the treadle. The operation of the machine needs no explanation, as it is used in the same manner and for the same purpose as any monitor. Any type of chuck may be used by suitable modification, and the design is well adapted for spring chucks as well as for the type shown. The device can be attached to any monitor lathe by simply bolting the shelf to the rear of the headstock and adding the necessary attachment.

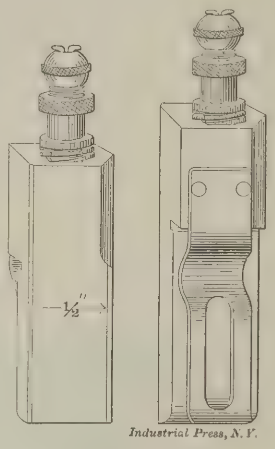


Industrial Press, N.Y.

Fig. 3. Mechanism Operating Chuck of Cahill Lathe.

UNIVERSAL RULE SLIDE.

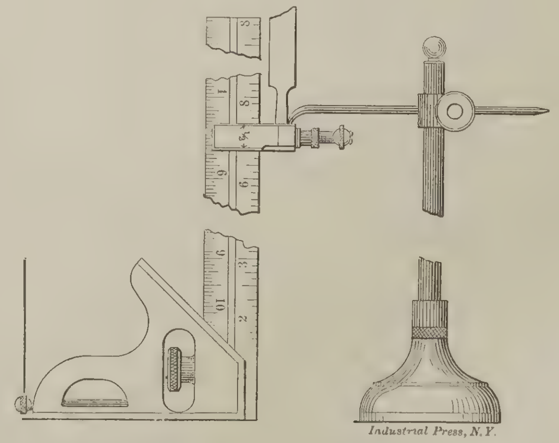
Mr. Robert A. Lachmann, a contributor to MACHINERY, has patented a universal rule slide for machinists' use which is manufactured by the Union Tool Mfg. Co., Chicago, Ill. This little slide, illustrated in Fig. 1, consists of an accurately constructed block cut out so as to form a shoulder to fit against the edge of a steel rule, and of a clamping device for holding it rigidly against this edge. An adjustable screw passes lengthwise through the block, and has a hook at its lower end by means of which the rule can be drawn against the shoulder. There is, in addition, a spring clip bearing against the side of the rule which produces enough friction to hold the slide in position, when the screw is loosened, and releases the hook. There is a hole through the screw for the reception of needle points, caliper points, pencil leads, etc., and the end of the screw is split so as to form a spring chuck for retaining these.



Industrial Press, N.Y.

Lachmann's Rule Slide.

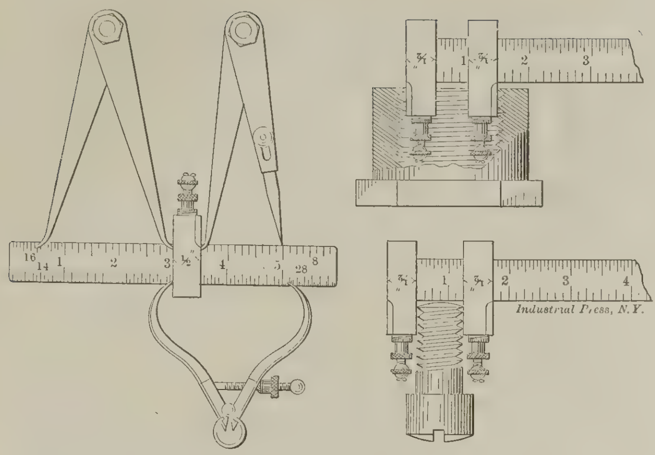
An attractive circular is issued showing the large number of uses to which these little devices can be put. In sketch on next page is shown how it can be used for setting dividers or calipers. By its use the setting of calipers from the end of the rule, which frequently has round corners, is avoided; and where the rule has fine graduations only a short distance from the ends, the slide is particularly useful in setting the calipers, as will be evident from sketch. Where a pair of slides is used on a scale the scale is converted into a caliper square for either outside or inside measurements, and by inserting suitable points it may be used as a trammel. Again, by the insertion of a steel needle in one slide and a pump center in the other, it is adapted for laying out other classes of work. Attached to the blade of a square, and with a straight point inserted, it is useful as a height gage; and if the blade of the square is graduated, as in the case of a combination square, it is adapted for setting a planer tool or surface gage. Provision is also made for using it as a depth gage.



Industrial Press, N.Y.

Application of Slide to Combination Square.

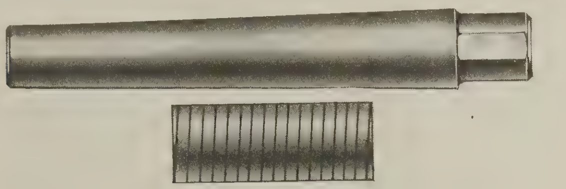
It is made in five sizes, and while it is not feasible to describe in these columns the many ingenious uses to which Mr. Lachmann applies his slide, these are fully explained in the circular.



Using the Rule Slide for Setting Calipers and also for Calipering Work.

THE RICH EXPANDING MANDREL.

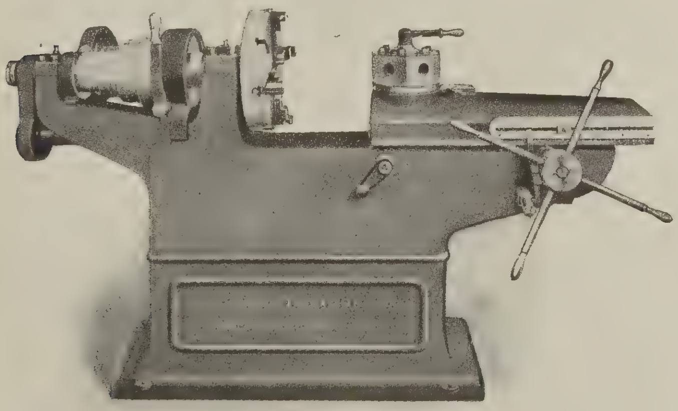
The taper arbor and spiral spring bushing fitting thereon, shown in the cut, forms an expanding mandrel, which is made by the Geo. R. Rich Manufacturing Co., Chicago, Ill., in sizes to accommodate diameters from 1 inch to 7 inches, inclusive. The taper arbor is made of tool steel, hardened and ground; the bushing is made of spring steel, wound in a close spiral and tempered. Both the inner and outer surfaces are accurately ground. It is pointed out that these mandrels are particularly adapted to chucking light work or pieces having thin sections, as there is no distortion or scoring, the spiral bushing expands uniformly and fits a bored hole throughout. A complete set comprises 16 taper arbors and 28 bushings—special sizes are made to order.



Rich Expanding Mandrel.

FRICTION HEAD TURRET BORING LATHE.

The cut herewith gives a very good idea of a turret boring lathe which has just been brought out to meet the requirements of the average machine shop. This lathe, being built to be used as a boring lathe only, embodies many features not found in the average boring lathe. This machine has a friction head which, with the use of the two driving pulleys on the countershaft, gives the operator sixteen speeds to the spindle. The lathe is also provided with quick change feed which can be used if desired while the lathe is in operation, giving every desirable feed that is required.



Davis Turret Boring Lathe.

There is a power feed with automatic stop and the turret is provided with six holes for tools and is also accurately faced on the six sides so that special forming tools can be attached if desired. The lathe is furnished with center rest, or tool rest, which supports the tool close to the work, but is not shown in the cut; and it is also provided with countershaft with two friction drive pulleys. It swings 24 inches. This machine is made by The W. P. Davis Machine Co., Rochester, N. Y.

A CUT-METER.

The Warner Instrument Co., Beloit, Wis., have placed an instrument on the market which is designed to fill a want of the high-speed steel user and which apparently will be very useful. It is called the cut-meter, and it is intended to show at a glance the speed at which work is running in the lathe or on the planer, or the peripheral speed of milling cutters. The speed is shown directly by the reading of the graduated scale without having to use a watch for timing, as is the case with the ordinary speed indicator. The graduations read in feet per minute traveled by the circumference of the wheel instead of in revolutions per minute, as usual. There is a rubber-tired disk on a shaft projecting from the instrument, and, to determine the speed, it is only necessary to hold the edge of this disk against the rotating piece and read the graduation. The rotation of the disk revolves a permanent magnet within the casing, and the lines of magnetic force transmitted through a thin aluminum disk to a soft steel ring behind it, tend to drag the aluminum disk around with the rotating magnet. But the rotation of the aluminum disk is resisted by a carefully calibrated hair-spring; therefore, its angular displacement is made proportional to the speed of rotation of the rubber-tired wheel pressed against the work. The displacement of the aluminum disk is indicated by a scale and pointer under a transparent cover through which the readings in feet per minute can be observed. The friction wheel shaft is mounted in ball bearings and the aluminum disk is mounted on hardened steel pivots working in sapphire bearings, the combination being designed to indicate readings with very little frictional resistance to the work and to be easily held in the hand.

GRINDING MACHINE.

A machine designed for straight, cylindrical and taper grinding has been brought out by the Diamond Machine Co., Providence, R. I. It is constructed in the most simple form possible, with a view to adapting it strictly to the class of work for which it was designed. A former is provided, by the use of which short abrupt tapers can be ground at any point in the length of the piece being finished. The base is unusually heavy, and the machine will take work 5 feet between centers.

* * *

PRESSED STEEL HANGER.

Fig. 1 herewith shows the 4-way adjustment pattern of the "American Pioneer" shaft hanger which is made of pressed steel by the Standard Pressed Steel Co., Philadelphia, Pa. It consists of two pressed steel legs, each strongly ribbed and flanged throughout its entire length, to secure rigidity and lightness, and so shaped at one end as to provide a broad and strong foot where bolted to the footing piece, while the other end is narrow and designed to fit the lower cross piece or

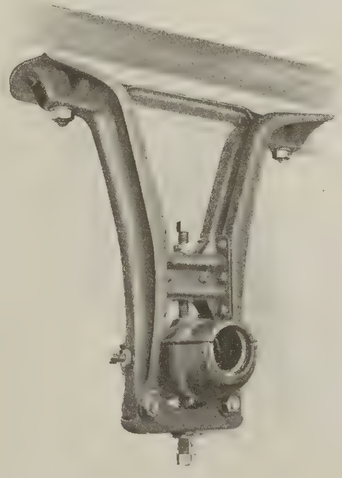


Fig. 1.

clamp, as shown. A flanged and corrugated plate of pressed steel connects the two feet and is riveted to them. The brace connecting the upper part of the parallel portion of the legs is also of pressed steel and riveted in place. This part not only acts as a brace but also takes the thrust of one of the vertical adjusting screws for the bearing. The lower vertical adjusting screw is supported by the clamp at the small end of the hanger, and by removing one of the two bolts which holds the clamp in position the latter may be swung out of the way, allowing the bearing to be dropped down and out of the hanger, which is often more convenient than sliding it endwise.

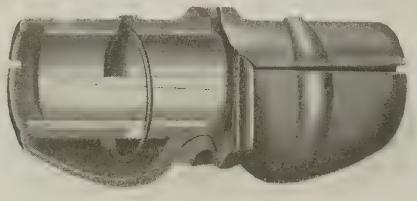
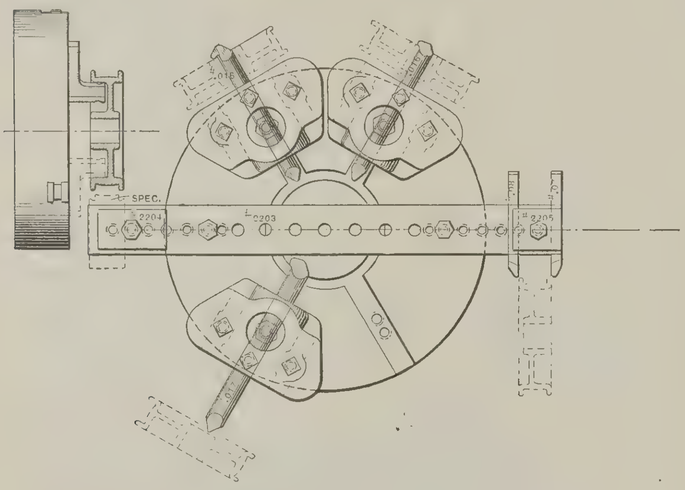


Fig. 2.

Special attention has also been given to the design of the bearing itself, as it was desired that it combine the advantages of the ball-and-socket principle with those of the 4-way adjustment.

The bearing consists of three parts: An upper and a lower half bearing and an oil pan, all made of cast iron—on the top of the upper and on the bottom of the lower; these half bearings are fitted with spheres having their common center in the center of axis of bearing. A socket of the same radius as that of the spheres is fitted centrally on the inside and in the bottom of the oil pan, which is made large enough to keep sufficient oil for lubrication, and at the same time to accommodate the lower half bearing, while a recess located centrally on the outside of the oil pan is provided for the lower adjusting screw. Thus when the complete bearing is put together and fitted between the adjusting screws, the two half bearings which bear on each other their full length, are supported on the socket in the bottom of the oil pan, and as plenty of clearance has purposely been provided between this and the half bearings wherever necessary to insure independent motion, these are left free to adjust themselves to fit the shaft, while the oil pan remains *stationary*, being firmly held by two horizontal and one vertical adjusting screw. The vertical adjusting screws are fitted in slotted holes, and can therefore, besides providing for liberal vertical also allow ample side adjustment—this latter being determined by the horizontal adjusting screws. To prevent the objectionable dripping of oil, automatic wipers have been fitted. The bearing is designed for ring oiling—the rings being of tempered spring steel, and will retain their original circular shape, thus insuring reliable and continuous lubrication. In case any other method of lubrication is desired it can be provided.



The Operations of Machining a Flange Pulley on the Flat Turret Lathe.

The proportion of this hanger have been carefully computed, and while it is much lighter than a cast-iron hanger, it is very much stronger, easier to erect and neater in appearance. The results of tests made by the Riehle Bros. Testing Machine Co. upon a cast-iron shaft hanger and a pressed steel shaft hanger have been sent us by the Standard Pressed Steel Co., and are as follows:

Cast-iron Hanger.

Load in pounds.	Deflection in inches.	Permanent set in inches.
200	.010	
500	.029	
1,000	.073	.024
1,500	.115	.037
2,000	.147	.048
2,500	.193	.06
3,000	.254	.085
3,500	.353	.133

After applying 3,500 pounds and observing deflection and set, the load was again applied to the hanger, the tension leg breaking when load of 3,500 pounds was reached.

Pressed Steel Hanger.

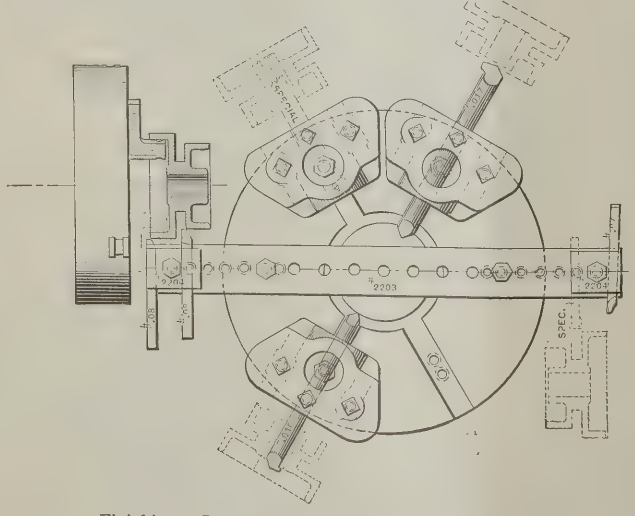
Load in pounds.	Deflection in inches	Permanent set in inches.
200	.0035	
500	.012	
1,000	.030	.003
1,500	.060	.02
2,000	.087	.028
2,500	.116	.038
3,000	.144	.056
3,500	.181	.074
4,000	.238	.110
5,000	.497	.299

After 5,000 pounds readings of deflection and set were not taken and the load was continued up to 7,160 pounds.

* * *

MEETING OF THE MACHINE TOOL BUILDERS' ASSOCIATION.

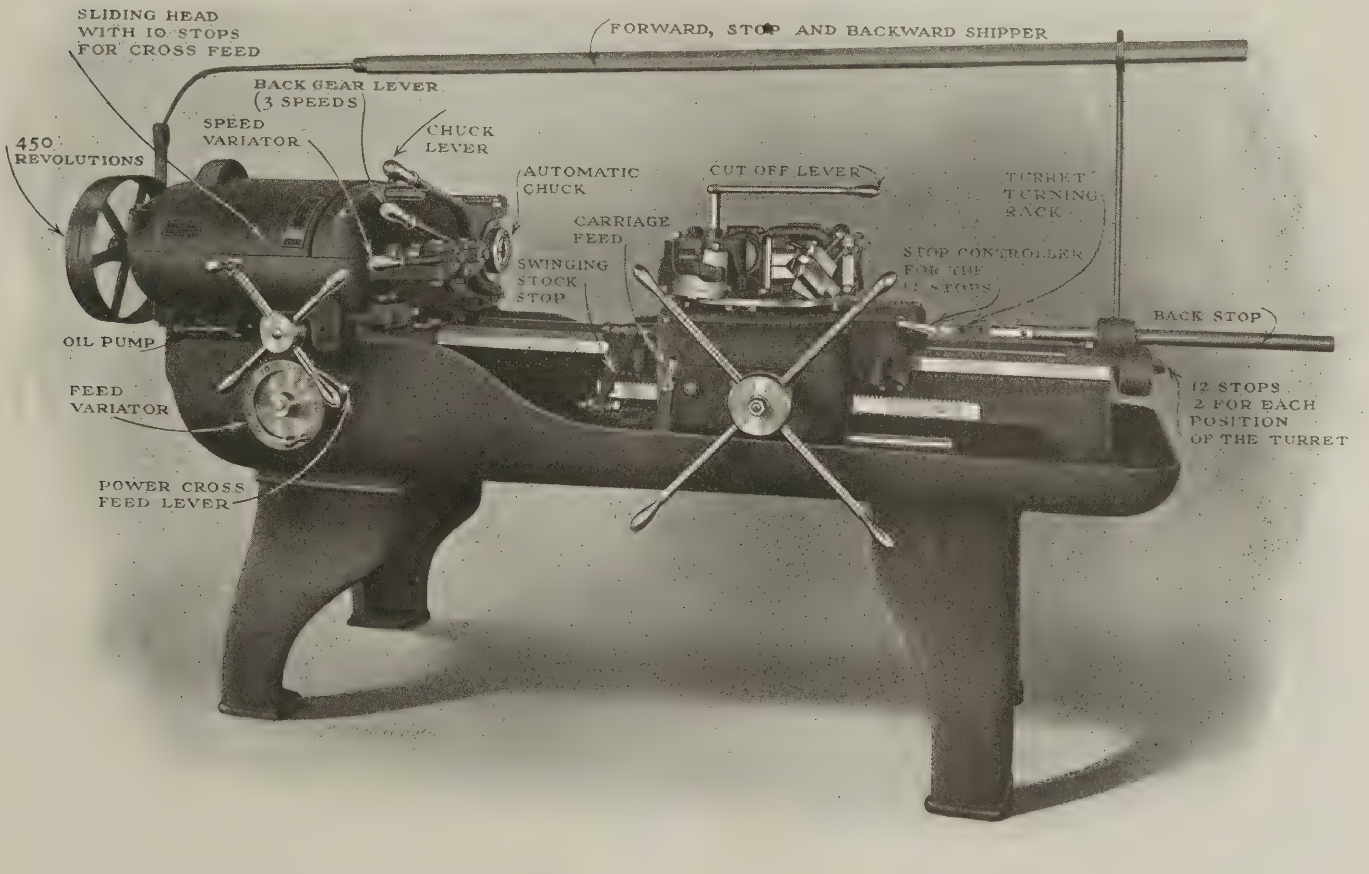
On Tuesday and Wednesday, April 26 and 27, the National Machine Tool Builders' Association held their semi-annual meeting at the Grand Hotel, in Cincinnati. The first session on Tuesday was devoted to the roll call, the reading of minutes, selection of convention committees, reports of standing committees, and other business matters. The following sessions were devoted to new and unfinished business and to the presentation of papers and their discussion. P. E. Montanus, secretary, gave an address in which he showed the work that had been done by the association of machine tool builders, and in which he presented strong arguments for belonging to the association. It is interesting to mention in this connection that Mr. Montanus has the honor of being the nominee as candidate for Congress from the Seventh Congressional District of Ohio, on the democratic ticket. Mr. Fred L. Eberhardt discussed the present status of the shaper trade, and Mr. A. F. Tuechter, the condition of the upright drill trade. The officers of the Association are: Wm. Lodge, of Cincinnati, president; W. P. Davis, Rochester, N. Y., first vice-president; F. E. Reed, Worcester, Mass., second vice-president; Enoch Earle, Worcester, Mass., treasurer, and P. E. Montanus, Springfield, O., secretary.



Finishing a Double Pulley on the Flat Turret Lathe.

NEW FLAT TURRET LATHE.*

The Jones & Lamson Machine Co., Springfield, Vt., have adhered to their policy of producing one style of machine for so many years that a new flat turret lathe, of which an illustration is shown herewith, will attract more than usual attention. This lathe is the result of extended experimental work, with a view to increasing the utility of this type of machine, and making it in every way adapted to the increasing demands of modern practice. The lathe is made in two sizes—called the 2 x 24 and the 3 x 36 sizes—and is designed not only for operating upon bar stock, but for machining pieces held in the chuck, up to 12 inches diameter in the smaller lathe and 14 inches diameter in the larger one. As heretofore, tools are supplied for machining almost any shape of work, and the old claim is maintained that single pieces can be finished in a shorter time on this machine than in an engine lathe, and also by the aid of the stops with which the different feeds are provided work can be turned out in quantity in the most economical manner.


SLIDING HEAD WITH 10 STOPS FOR CROSS FEED
FORWARD, STOP AND BACKWARD SHIPPER
BACK GEAR LEVER (3 SPEEDS)
SPEED VARIATOR
CHUCK LEVER
450 REVOLUTIONS
AUTOMATIC CHUCK
CUT OFF LEVER
TURRET TURNING RACK
CARRIAGE FEED
SWINGING STOCK STOP
STOP CONTROLLER FOR THE 12 STOPS
BACK STOP
OIL PUMP
FEED VARIATOR
12 STOPS 2 FOR EACH POSITION OF THE TURRET
POWER CROSS FEED LEVER

Flat Turret Lathe—Operates on Castings and Forgings as well as on Bar Stock.

A glance at the view of the machine will show that the greatest changes have been made in the head and bed, while the turret is substantially as heretofore, although this, too, has been changed in some particulars. Aside from the general appearance of the machine the most important changes in its design are as follows:

1. Power is received on a single pulley, and the spindle is driven by a gear mechanism enclosed in the head, through which all the changes in both directions are obtained. The headstock which encloses this gear mechanism is in the form of a shallow pan in which a supply of oil reaches the lower half of the running parts, and the same scheme also provides for the lubrication of the main bearings of the spindle. The entire mechanism is covered by a cast-iron hood.

2. In order to adapt the machine to operating on work held in the chuck the headstock is mounted on guide ways running across the machine, making it possible to give the work a cross feed relative to each tool on the turret. Absolute return of the spindle to its central position is assured, by giving the head travel in one direction only and bringing it against a positive stop in the opposite direction.

3. The machine is provided with variable longitudinal and cross feeds by mechanism similar to that employed for the variable speeds of the spindle.

4. The feed mechanism is such that the feed pulls the carriage, or head, as the case may be, with a maximum pressure solidly against a positive feed stop and holds it there under strong pressure until disengaged by the operator. Heretofore the stop mechanism for the feeds would throw out the feed just before the tool reached the desired point, and it was not possible to bring the tool to precisely the same point successively on different pieces. This is a decided improvement in the production of accurate duplicate work.

5. Twelve stops are now provided for the turret instead of six, making two for each tool, and the cross feed for the head is provided with ten stops.

6. In the matter of lubrication, the jointed pipes heretofore employed are no longer required, the oil being delivered to a pipe connected to the under side of the turret carriage, from whence the oil passes up through the turner that is in working position and comes out above the cutting tool in a steady stream.

In the tool equipment the regular turners and other tools, such as were employed on the older machines for bar work, are used on this machine, and in addition there is a simple equipment of turning and boring tools adapted for almost any class of work held in the chuck. The method of using these tools will be evident from the illustrations on the previous page, where the rotation of the turret is indicated by the dotted lines showing the work in the successive positions it would occupy relative to the various tools. What this machine therefore provides is self-contained variable speeds and feeds, 22 positive stops for the work and tools together, and an equipment of simple but universal tools.

* * *

The date of the first telegram received in Chicago and of the first railway train to run over a track within its limits is 1848.

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* The illustrations are from the new catalogue of the lathe, about to be issued.

FRESH FROM THE PRESS.

Commutator Construction, by William Baxter, Jr., is the third of the series of little pamphlets which are being published by the Derry-Collard Co. at 25 cents each. These may be called single-topic pamphlets or monographs, each dealing with one subject in a simple manner.

The Industrial Publication Co., 16 Thomas St., New York, have sent us several copies of their books for woodworkers, carpenters and architects, most of which sell at from 50 cents to $1.00 each. One of these is a series of questions and answers upon the principles and progress of architecture; another pertains to practical carpentry, and a third to estimating the cost of wood work.

Engineers' Arithmetic. By Fred H. Colvin and Walter Lee Cheney. Published by the Derry-Collard Co., 256 Broadway, New York. Price 50 cents.

Machine Shop Arithmetic, by Colvin & Cheney, is well known to a large number of the readers of Machinery, and it has been one of the most popular books published for those in the machine shop. *The Engineers' Arithmetic* contains such of the matter of the first-mentioned book as is of use to the engineer and, in addition, a discussion of the principles used in calculations that an engineer should know how to make. A brief glossary of terms is also given.

The Factory Manager and Accountant. By Horace L. Arnold. Published by the Engineering Magazine Co., 120 Liberty St., New York. 432 pages. Illustrated. Price $5.00.

The former work by Mr. Arnold—the *Complete Cost Keeper*—has been considered one of the most important treatises on cost keeping that has been published. The new volume is somewhat different in its scope, being composed entirely of descriptions of systems in actual use in a number of manufacturing plants. There are nine of these systems described in detail. All blanks and forms referred to in the text are reproduced, each one having its size given, together with the color and kind of paper on which it is printed. The aim is to explain the methods of successful factory managers in such a way that anyone can estimate the value of the system for his own use.

The Technical World is the title of an attractive monthly periodical that is now being published by the American School of Correspondence, at Armour Institute of Technology, Chicago, Ill. It is a journal about the size of the average 10-cent popular magazine, and each issue covers some of the interesting subjects occurring month by month in the technical field. All the articles are written in a popular style, adapting them to the general reader, and while most of the articles are of a descriptive nature, there are a few in each issue which may be classed as educational. There is a department reviewing current technical literature, and one containing questions and answers. The magazine was started primarily for the benefit of the students of the American School of Correspondence, but it is as well adapted to the general reader as to the students of this school.

The Polar Planimeter. By J. Y. Wheatley, C. E. Published by Keuffel & Esser, New York. 114 pages, with several folding charts. Illustrated. Price $3.00.

In explanation of this book the author says that he once placed an order for a planimeter and, having read the directions for use furnished by the maker, was not satisfied with them and wrote the firm asking for the best treatise on the subject, to give him the information necessary to make an intelligent use of the instrument. The reply was that no such treatise was published, and this led him to study up the subject. He first took up the theory of the planimeter and then considered the numerous engineering problems by which that theory could be applied. This book is the result of his labors. The author believes that the planimeter is of far greater value as an aid in engineering calculations than has been supposed. The chapters, besides containing descriptive matter and dealing with theory, consider the measurements of areas; problems involving average; and measures of quantities of materials—this latter being treated very fully and including many applications of the instrument that the average user of the planimeter has probably not thought of.

Change Gear Devices. Oscar E. Perrigo. Published by the Derry-Collard Co., 256 Broadway, New York. 81 pages. Illustrated. Price $1.00.

Some time ago the author of this book had occasion to make a careful examination of the subject of change gear devices for engine lathes. From among the United States patents on such devices he finally selected twenty-nine that appeared to him to be of the greatest importance in the development of this part of the mechanism of the engine lathe. Drawings were prepared from these twenty-nine patents and a description of each was written, forming a series of articles that was later published in Machinery. These articles attracted wide attention, because at the present time nearly all the machine tool builders have either adopted, or are considering the adoption of some form of gear feed mechanism by which a positive and easily changed feed can be obtained. This book contains the articles published in Machinery, with some additions and revisions. While the devices illustrated pertain mainly to those used in connection with screw cutting, most of them are capable of use also as regular feed mechanism on lathes or other tools.

The Metric Fallacy. By Fred A. Halsey and Samuel S. Dale. Published by the D. Van Nostrand Co., 23 Murray and 27 Warren Sts., New York. Price. $1.00.

Mr. Halsey's strenuous efforts to avert the metric calamity which he and many others believe has hung over this country like a threatening cloud, have attracted almost universal attention in the industrial world. This book is the outgrowth of his paper upon the subject presented to the American Society of Mechanical Engineers, but contains numerous additions and data more lately secured, and also an extensive treatment of the questions as related to the textile industries, by Mr. Dale. This volume contains the greatest mass of information and argument in favor of retaining the English system of units that has probably ever been gotten together by all other writers combined. While we think the metric danger may have been somewhat overestimated, we are opposed to the introduction of the metric system in machine shop practice, and the reading of this book will tend to allay any doubts one may have as to the advisability of retaining our system of English units, imperfect as it is.

The Steam Turbine. By Robert Neilson. Published by Longmans, Green & Co., London and New York. Second edition. 294 pages. Illustrated. Price $3.50.

The valuable feature of this book is a list of English patents on the turbine, down to the year 1902. From this list the author has selected such as seem to him to be of the greatest importance and he has published drawings and descriptions of these. The leading turbines of the day are described, and in the new edition additional matter is given upon the Stumpf, Schulz, Curtis, Seger, and other of the more recent machines. The theory of the steam turbine, including the flow of steam and the proportioning of the guide vanes and blades, is touched upon to a rather limited extent. There is one chapter upon the vanes and one short chapter upon the theory of the action of the steam. These two chapters could profitably be extended as they treat of the branches of the subject that most people are not familiar with, while the descriptive matter which is given, although carefully prepared, is much of it available elsewhere. We think the most valuable portion of the book is the historical review.

Compendium of Drawing. Published by the American School of Correspondence, at Armour Institute of Technology, Chicago, Ill., in two volumes. Illustrated. Special price until June 1st, $3.00 per volume, or $5.00 for both volumes.

Part I. takes up elementary drawing, projection, descriptive geometry, shades and shadows, perspective drawing, lettering (including architectural lettering) and free-hand sketching. Part II. treats of machine drawing, the elements of mechanism, the elements of machine design, and laying out sheet metal work. Both volumes are profusely illustrated, mainly with original engravings.

We have previously taken occasion to refer favorably to the instruction papers upon mechanical drawing issued by the American School of Correspondence. These two volumes contain the papers before mentioned and, in addition, several papers such as those on mechanism, free-hand drawing, lettering, sheet metal work, etc. The machine design and mechanical drawing papers are by Prof. Griffin who, as we have said, adopted an entirely original and, we believe, very practical plan—quite out of the ordinary—for teaching the subject. They also contain the excellent paper on perspective drawing by Wm. H. Lawrence, associate professor of architecture at Massachusetts Institute of Technology. One other paper is by Frank C. Brown, architect, Boston, and by Wm. Neubecker, instructor of the sheet metal department, New York Trade School. The balance are by Prof. Gardner and Instructors Gregg, Kenison and James, at Massachusetts Institute of Technology.

It will be seen from the foregoing list that the several papers have been prepared by men entirely competent to do the work well, and who have devoted particular attention to the subject upon which they write. In many respects, therefore, we think this compendium is of greater value than a text book written by one man, covering the same list of subjects. The only objection to such an arrangement is a possible lack of continuity, which, however, is not at all serious in this instance. We believe that the books will impress one, upon careful examination, as being well written, thorough and satisfactory.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

The Bessemer Gas Engine Co., Grove City, Pa. Neat folder calling attention to the Bessemer gas engine oil.

The London Machine Tool Co., London, Ont. Illustrated catalogue of planers and shapers. The planers are built in sizes from 20 to 72 inches, and the shapers from 16 to 24 inches.

The Hill Machine Co., Anderson, Ind. Bulletin No. 2, which is intended as a supplement to their 1901 catalogue. It illustrates some of the pumping machinery which has been perfected since the issuance of their catalogue.

The S. A. Woods Machine Co., Boston, Mass. Folder containing an illustration and description of the company's No. 221 full automatic knife grinder, built to grind up to 42 inches in length. Their 222 grinds up to 78 inches.

The American Tap & Die Co., Greenfield, Mass. Pocket size catalogue and discount sheet of machine screw taps, hand taps, nut taps, tapper taps, boiler taps, long and taper hob taps, short plug hob taps, pipe taps, pipe reamers, adjustable dies, etc.

The W. J. Clark Co., Salem, O. Pamphlets Nos. 5, 6 and 7 regarding the "Quick as Wink" couplers. The first of these deals with couplers of this type for air, steam or gas hose; the second, with couplers for water hose, and the third for fire hose.

The R. A. Kelly Co., Xenia, O. Catalogue H of crank shapers. This line of shapers has been redesigned and the company here call attention to some of the new features. Single geared and back-geared shapers of different sizes are shown and described.

Geo. Owen & Co., Ltd., 95-97 Liberty Street, New York. Advertising matter regarding this company's "Red Cross" cement, for use in making screwed joints for steam, gas, water or air pipes. A leaflet describing the cement, a price list and a postal containing a trial offer have been issued.

The Northern Electrical Mfg. Co., Madison, Wis. Bulletin No. 35 and a number of leaflets showing the application of the Northern motor to lathes, milling machines, grinders, turret lathes, boring mills and pumping machinery of prominent makes. The bulletin contains a full description of the "Northern" motor.

The F. Bissell Co., Toledo, O. Bulletins Nos. 36 and 37, the former illustrating and describing various kinds of batteries and battery supplies, and the latter presenting house goods, such as annunciators, call bells, buzzers, push buttons, speaking tubes, telegraph apparatus, etc. These bulletins will be sent prepaid on request.

The General Pneumatic Tool Co., Montour Falls, N. Y. Circular and leaflets of the products of this country. These include pneumatic tools, compression riveters, air compressors, cranes, etc. The circular shows a number of riveters at work, and one style of riveter whose stake may be swung in any direction and will operate on flanges standing in any position.

The O. S. Walker Co., Worcester, Mass. Illustrated catalogue of the Walker magnetic chucks, for use on surface grinders, iron planers or shapers, and for holding, without the use of bolts, straps or jaws, iron and steel parts of machines. The different types are: Flat chucks, tool room chucks, universal swiveling chucks, rotary chucks, all illustrated in the catalogue, and which are made in various sizes.

The Brown Hoisting Machinery Co., Cleveland, O. Illustrated booklet treating of "ferro-inclave." This new product, described in Machinery, October, 1903, issue, is for use in the construction of roofing, siding, flooring, etc. It consists of corrugated steel sheets made in dovetail form so that one sheet will shingle edgewise into the other. Over this is laid a covering of cement, which makes the construction strong, water-tight and durable.

The Cincinnati Shaper Co., Cincinnati, O. Catalogue C, April, 1904, of shapers. These are shown in the following sizes: Crank shapers, 16, 20, 24, 26 and 30 inches; traverse shapers, with one or two heads, and single or back-geared, 18, 20, 24 and 36 inches. Several pages are devoted to the attachments used on these shapers; and crank shapers and traverse shapers equipped with electric drive also appear. The company call attention to their new shop, located at Elam St. and Garrard Ave., and present a fine half-tone view of same.

The Scully Iron & Steel Co., Chicago Ill. Illustrated pamphlet describing the Lovekin metal expanding tools. It is stated that these tools are based on an entirely new principle and have been designed for expanding and flanging pipe, from the smallest size boiler tube to the largest lap-welded piping made, and also for expanding valve seats, etc. The new method is the invention of L. D. Lovekin, and is fully treated in this pamphlet, which also contains a large number of drawings showing the features of the device.

The S. Obermayer Co., Cincinnati O. General Catalogue No. 40. This is a cloth-covered book, containing 370 pages, and the company's announcement that it is intended to cover "everything you need in the foundry," appears a true one. The catalogue is very complete and com-

MACHINERY.

June, 1904.

COMMENTS ON DRIVES FOR HIGH-SPEED CUTTING TOOLS.

C. E. COOLIDGE.

C. E. Coolidge.

What has been considered in the past as marvelous in the performance of high-duty cutting tools may now be considered quite tame when compared with the proven results of air-hardening cutting tools. The metallurgist has proven to us, and a great many machine tool builders have satisfied themselves by practical experiment, that the high-speed cutting steels are at our service, but they must be properly shod if they are to be used to the best advantage.

Some few concerns who have experimented with the high-speed steels and who anticipated much have signally failed to their utter discouragement through lack of a proper analysis of the conditions which accompany the use of the high-speed cutting steels. It takes but a moment's reflection to convince one of the absurdity of trying to get as effective a fire from a six-inch as from a thirteen-inch gun, even though the same explosive charge is used in both.

Some view this unusual commotion about the new cutting steels as being somewhat fanatical or a fad which will rage for a time and then die a natural death as many others have done. True, this is not the first high-duty cutting steel which has been advanced with enormous claims of efficiency. Mushet steel has been on the market for several years and the great things predicted for it we must admit did not fully meet everybody's expectations. The chief reason for this was its far too limited use in a great many cases, on account of its being expensive, difficult to forge, grind, and to get a satisfactorily finished surface with it, and the failure of the machine to stand up to the chip it could take. Then again, when Mushet steel was introduced competition among machine tool builders for increased product from their machines did not begin to compare with that which now exists with firms which more than ever are on an intensely manufacturing basis. Manufacturing plants of any considerable size using metal cutting tools are bidding nowadays for specially designed machinery of the simplest form to augment the output of a single product and not for comparatively complicated combination tools, designed for many operations on many pieces and which save considerable room and first cost of installation but are of necessity inconvenient, and unsuitable for high-duty service.

The complaint which has been made by some that the new high-speed cutting steels are unfit for finishing surfaces cannot be consistently sustained. The modernly designed manufacturing grinder has unquestionably proven to be the proper tool for finishing surfaces from the rough; and undoubtedly, and beyond peradventure, the grinder is the natural running mate for the high-duty turning lathe and planers; and it seems probable that, instead of the grinder being a rarity and a luxury in shops as a sort of tool room machine, it will be as much in evidence for manufacturing purposes as the more commonly known machine tools of the present, or more so.

The innovations of the day in machine tool evolution are in most remarkable harmony and synchronism. The electric motor, which is fast developing for economy and convenience into the approaching indispensable, and independent machine drive, demands a high speed for maximum efficiency of the motor; and what do we find contemporaneously developed but the high-speed cutting steels, the practicable commercial grinder, and the comparatively high-speed mono-stroke milling machine to supersede the comparatively slow multi-stroke planer? Unquestionably, there never has been in the whole history of the machine tool business such an opportunity for the enterprising capitalist, the engineer, and the designer to invest their money, brains, and skill in a type of machine tools that will be as different from the present type as the nineteenth century lathe is from the simple and crude Egyptian lathe of tradition.

The development of the cutting or producing end of the machine appears to be further advanced than the driving end. The direct motor drive without inter-connecting belts, chains, and gears is undoubtedly the simplest, most convenient, and most effective. The motor which is most desired has not been designed but it should be a comparatively slow-speed motor having high efficiency, whose speeds vary by infinitesimal steps between its minimum and maximum limits, fully as simple as the "commutatorless" type and with far higher pressures than is now used. In the meantime, during the process of development, we shall have to be content with the usual compounding elements between the motor and the driving spindle; but these compounding elements, in order to keep up with the procession, will naturally undergo revolutionary changes in design to meet the demands of cutting tools for more power.

The silent chain drive and the high-speed motor are mutual helpmates; geared variable speed devices and single speed induction motors are well wedded; but cone pulleys are practically just beginning to receive that examination and attention which can fit them for the service of higher speeds.

In the case of a turning lathe, as would naturally be expected, we are very much limited in the range of the sizes of pieces that can be turned—if we maintain an efficient range of speeds and sufficient diameters and widths of pulleys for surface speeds of belts—unless we use an abnormally ponderous cone pulley, which is entirely out of the question. To make this point clear, it may be well to analyze a specific case. We will assume that the lathe is designed with a four-stepped cone and with "front gears" (the speed ratios of front gears figure the same as back gears but their thrust at the front box is opposite in direction to that of the back gears and to the lifting effect of the tool, as it properly should be), two countershaft speeds, and for cutting 30-point carbon steel at a speed of 100 feet per minute with a chip of 5-16 by 3-32 inch cross section. It is furthermore assumed that the work and cutting tool are rigidly supported and that the cutting tool has the proper amount of rake for least resistance and a fair amount of endurance.

Calculation of Cutting Force of Tool and Speed of Belt.

In order to make absolute computations of the required diameters, we should have reliable data on the amount of cutting force at the cutting edge of the tool when cutting the various metals at high speeds, reliable data for the best efficiency of the redesigned machine, and the approximate distance between the centers of the driving spindle and countershaft. Several experiments were made by Hartig and subsequently by others on the horse power required at the cutting edge of a tool when cutting various metals at slow speeds with the ordinary tempered steels. The horse power was determined

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C. E. COOLIDGE, the author of this article, was born April 6, 1870, at Willimantic, Conn. After leaving the Hartford High School he served an apprenticeship of four years at Pratt & Whitney Co., and worked for the same firm as a journeyman machinist for one year. He graduated with the class of '95 from Yale Scientific School, and served three years as draftsman with the Pope Tube Co. and the Eddy Electric Mfg. Co. Then he held successively the positions of Instructor, Adj. Professor, and Assistant Professor in the Worcester Polytechnic Institute, the Georgia School of Technology, and the Sibley College respectively. Mr. Coolidge is the author of several articles published in MACHINERY, and other technical journals.

by multiplying the weight of chips turned off per hour by a constant whose value varied with the degree of hardness of the metal cut and the conditions of the cutting edge of the tool. The average of the several constants for about 30-point carbon steel seems to be about .035.

Hartig's expression is given in the formula

$$H.\ P. = c\ W = .035 \times \pi \times D \times n \times d \times t \times .28 \times 60 \quad (1)$$

and the usual expression for horse power is given in the form,

$$H.\ P. = \frac{F\,S}{33000} = \frac{F \times \pi \times D \times n}{33000 \times 12} \quad (2),\text{ in which}$$

$H.\ P.$ = horse power absorbed at the cutting edge of tool.
c = constant .035.
W = weight of chips per hour.
D = mean diameter of the area turned off per hour.
n = revolutions per minute.
d = depth of chip.
t = thickness of chip.
.28 = assumed average weight per cubic inch of 30-point carbon steel.
F = force at cutting edge of tool.
S = distance through which force F acts.

Equating (1.) and (2.),

$$F = .035 \times .28 \times 60 \times 33000 \times 12 \times d \times t = 232900dt.$$

Since the chip assumed to be cut is 5-16 by 3-32 inch cross section, then the force at the cutting tool is

$$F = 232900 \times 5\text{-}16 \times 3\text{-}32 \text{ inch} = 6825 \text{ pounds.}$$

If the cutting speed is 100 feet per minute then the work at tool

$$W = 6825 \times 100 = 682500 \text{ foot pounds.}$$

If the efficiency of the machine is assumed at 85 per cent., then the effective work of the belt must be

$$W = \frac{682500 \times 100}{85} = 803000 \text{ foot pounds.}$$

We will assume that a 5-inch double belt is the practical limit for the belt which can be conveniently used on the machine, and that the effective pull is 70 pounds per inch width when wrapped around a cast iron pulley with a contact surface of 180 degrees. The total effective pull is then

$$5 \times 70 = 350 \text{ pounds pressure.}$$

Since our belt must deliver 803000 foot pounds per minute, its velocity will be

$$V = \frac{803000}{350} = 2295 \text{ feet per minute, which must be propor-}$$

tional to the diameters of the cone pulleys and the countershaft speeds which are obtained as follows:

It is customary to consider speeds in a series of geometrical progression if the most efficient and convenient range of speeds is desired. The constant multiplier will then be

$$r = \left(\frac{l}{a}\right)^{\frac{1}{n_1 - 1}},\text{ in which} \quad (3)$$

r = constant multiplier.
l = maximum R. P. M. of spindle.
a = minimum R. P. M. of spindle.
n_1 = number of speeds.

Let it be assumed that the lathe is designed to turn sizes from 1 to 6 inches. The corresponding maximum and minimum revolutions per minute for the cutting speed 100 feet per minute are 382 and 62 respectively. Then from (3)

$$r = \left(\frac{382}{62}\right)^{\frac{1}{15}}$$

$$\log r = \frac{1}{15} \log 6.16$$

$$r = 1.128$$

The whole series of speeds in geometrical progression and the diameters of stock, which will approximately correspond, if a cutting speed of 100 feet per minute be used, is given in the following table:

SPEEDS IN R.P.M.	DIAMETER OF STOCK			SPEEDS IN R.P.M.	DIAMETER OF STOCK		
382	1	CONE PULLEY SPEEDS	FAST COUNTERSHAFT SPEED	145	$2\frac{5}{8}$	CONE PULLEY SPEEDS	SLOW COUNTERSHAFT SPEED
338	$1\frac{1}{8}$			128	3		
300	$1\frac{1}{4}$			113	$3\frac{3}{8}$		
265	$1\frac{1}{2}$			101	$3\frac{3}{4}$		
235	$1\frac{5}{8}$	BACK GEAR SPEEDS		89	$4\frac{5}{16}$	BACK GEAR SPEEDS	
208	$1\frac{13}{16}$			78	$4\frac{7}{8}$		
184	$2\frac{1}{16}$			69	$5\frac{1}{2}$		
163	$2\frac{3}{8}$			62	6		

Industrial Press, N.Y.

In the sketch assume that the countershaft and spindle cone pulleys are the same size, as is usually the case for the engine lathe. Let

D_1 = diameter of largest step.
D_4 = diameter of smallest step.
n' = slowest speed of countershaft.
N_1 = fastest speed of spindle to correspond with slowest countershaft speed.
N_4 = slowest speed of spindle without back gears to correspond with slowest countershaft speed.

$$\text{Let } \frac{D_1}{D_4} = r \quad (4)$$

$$\frac{D_4}{D_1} = \frac{1}{r} \quad (5)$$

Then

$$n' \times r = N_1 \quad (6)$$

$$n' \times \frac{1}{r} = N_4 \quad (7)$$

Combining (6) and (7),

$$n' = \sqrt{N_1 \times N_4} \quad (8)$$

Substituting in (8) the proper speeds taken from the table,

$$n' = \sqrt{145 \times 101} = 121$$

From (6)

$$r = \frac{N_1}{n'} = \frac{145}{121} = 1.199$$

$$D_4 = \frac{V}{\pi\, n'} \quad (9)$$

Substituting in (9) the value of V and n',

$$D_4 = \frac{2295 \times 12}{3.14 \times 121} = 72\tfrac{1}{4} \text{ inches}$$

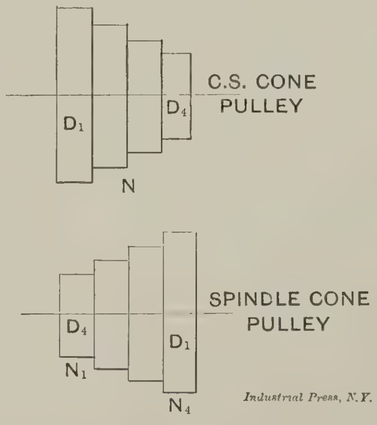

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Diagram of Cones.

From (4)

$$D_1 = r \times D_4 \quad (10)$$

Substituting in (10) the value of r and D_4

$$D_1 = 1.199 \times 72\tfrac{1}{4} = 86\tfrac{1}{2} \text{ inches}$$

The front gear ratio from spindle cone speed to driving spindle speed will be $\frac{145}{89} = 1.629.$

Since the values of the constants used in computing the force at the cutting tool were taken from experiments made with slow cutting speeds and would be considered low in view of the fact, noted by some, that the work at the tool for high speeds increases in far greater proportion than the increased cutting speeds; and since the assumed 70 pounds per inch width for effective pull at the belt is quite liberal, it is clear that the pulleys are practically at a minimum size under the conditions assumed. It is therefore convincingly apparent that for the ordinary back geared head, belts can be of no avail for high-speed cutting except for extremely limited ranges of diameters of stock.

If the diameters of the pulleys are reduced by speeding up the belts and gearing down the spindle, nothing is availed in most cases but an added and useless expense, since every compounding element is a loan for a mortgage whose interest rates sometimes increase pretty nearly in a geometrical progression.

"Figures speak for themselves" is enough said after an inspection of the above results.

* * *

Perhaps one of the best indications of the advance of engineering knowledge during the past seventy-five years is the general substitution of rational formulas for the old rules-of-thumb and empirical prescriptions laid down for the guidance of early engineers. An example of these crude rules is given by Mr. Edwin F. Smith in a paper "Some Early Engineering Works in Pennsylvania," read before the Engineers' Club of Philadelphia. It has reference to the length of rails and was formulated in the days when cast iron and wrought rails were on about an even footing; it was designated as "Rule for the Best Length of Rails of Railroads" and reads as follows: "The price of a ton of iron delivered on the railroad must be known, and also the price of the chair, stones and setting one support. Then divide the price of a ton of iron by the price of one support, both being in dollars; square the quotient and multiply it into the breadth of the rail in inches, and this product by one-twentieth part of the weight of the wagon in pounds, and extract the cube root of the product; divide 700 by the cube root found, and the result will be the length of the rail in feet." The rule was supposed to apply to cast iron rails only.

* * *

The so-called fireproof paints used to some extent on interiors of shops are chiefly valuable for their lighting effect, being white. Whitewash is practically as effective in preventing the spread of small fires and is equally as effective in lighting gloomy interiors—besides it is much cheaper. Where something better in appearance than ordinary whitewash is wanted the following receipt is said to make a glossy and durable covering for wood and brick walls: For each five gallons of water a pound of rice is boiled soft and thoroughly triturated by being rubbed through a fine sieve. The water should be boiling hot when the rice water is added, and at the same time one peck of lime and one pound of salt are thoroughly mixed through, and boiled up. To get the best results this whitewash should be applied hot.

EARLY STEAM ENGINES.

SOME OF THE EARLIEST WORK OF INVENTORS.

A. R. BELL.

Among the many inventions of man to administer to the necessities and to augment the luxuries of life by mechanical means, none have proved more valuable than the steam engine. Many discoveries have involved more intellectual power as well as more varied ingenuity in construction, but estimating the importance of causes by their consequences the steam engine must stand as one of the proudest monuments of mental conception.

It is not only as a prime mover that the importance of the steam engine is to be regarded—innumerable branches of mechanical art have developed from it contributing to the manufacturing world instruments of such power and obedience that no human being could replace.

Hero, of Alexandria, we find mentioned in records of antiquity as being the first inventor of the steam engine. In his early writings he describes three modes of raising water by the power of steam. Hero, it must be remembered, flourished about 130 years before the birth of Christ.

The next attempt must be attributed to a Frenchman, Solomon de Caus, an eminent engineer who lived early in the seventeenth century. His engine was somewhat similar to that of Hero, and consisted mainly of a boiler with two pipes inserted. One of the pipes reached nearly to the bottom of the vessel, while the other first penetrated through the top and was fitted with a valve. The boiler was nearly filled with water and a fire lighted beneath it raised steam. The valve on the short pipe being shut, as soon as steam was formed a fountain of boiling water escaped from the long pipe, Fig. 1.

In 1629 an Italian—Branca by name—published a book in which he described a steam engine which bore certain mechanical details quite in advance of Hero and De Caus. He arranged a wheel on an axis above the boiler, which carried vanes on the periphery—and a jet of steam caused it to revolve.

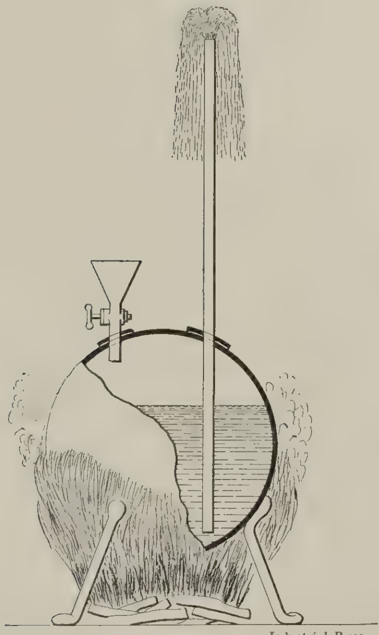
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Fig. 1. Solomon de Caus Engine.

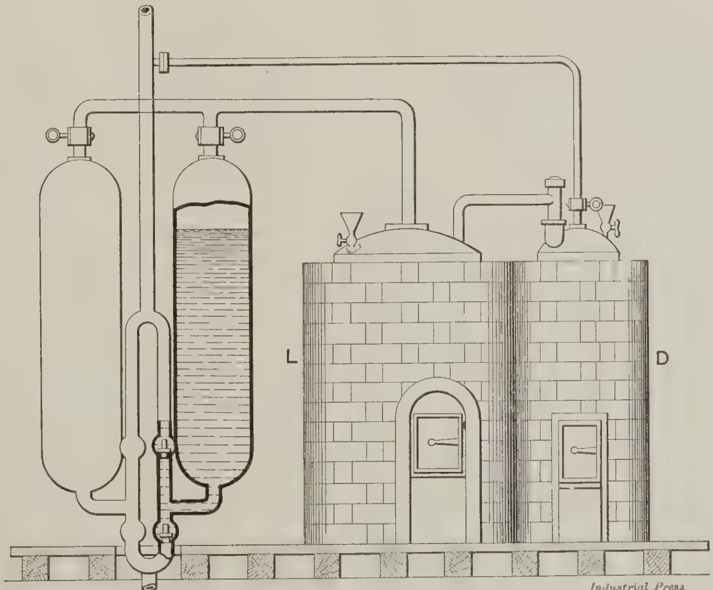

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Fig. 3. Capt. Thos. Savery's Engine.

Until the publication of "The Century of Inventions," by the Marquis of Worcester, in 1663, the gigantic capabilities of steam had been almost unknown. The Marquis had a mind ardently disposed to mechanical projects. His first experiment was with a cannon with which he demonstrated the tremendous force of steam by stopping up the mouth and touch hole, nearly filling it with water, and applying heat. We can well believe from his writings that within 24 hours it burst with a great noise. The original manuscript of this work is still preserved in the British Museum, London.

It is generally understood that the Marquis constructed an engine to raise water by steam, and with it he succeeded in forming a fountain of water forty feet high. Fig. 2 shows this engine as fairly as records will allow. For the boiler arched iron plates with their convex sides turned inward were joined by bolts a few inches apart; outside stay rods were also provided. It will be seen that a boiler constructed on these lines would restrain internal pressure provided the stay-rods and plates were proportioned. The action of the engine can be followed from the illustration and hardly requires a detailed description. Steam and water were admitted alternately to the two vessels containing the delivery pipes.

In 1699 Captain Thomas Savery obtained a patent for raising water and giving motion to all kinds of mill work by steam. From the illustration, Fig. 3, it will be noted that this engine was an improvement upon the Marquis of Worcester's, for it not only raised water by the expansive force of steam, but the condensation was utilized also in raising the water by atmospheric pressure. The receivers being in duplicate an almost continuous stream of water was kept up. In referring to the illustration of Savery's engine, the boiler is shown at *L*, the vessel *D* being an auxiliary boiler.

While improvements and modifications of Savery's engine were engaging the attention of mechanics, Thomas Newcomen and John Cowley, of Dartmouth, two Devonshire men, were busily employing their minds in a series of experiments. Newcomen was not an educated man, but did not lack in inventive skill. It is not known to what extent Cowley participated in the invention, but doubtless he furnished funds for the experiments. The first patent was taken out in 1705 for an atmospheric engine (see Fig. 4). It consists essentially of a cylinder and piston connected to a beam engaging with a weighted pump rod. The downward stroke of the piston was effected by atmospheric pressure on the upper side of it, the under side being subjected to the pressure of live steam from the boiler at the will of the man working the steam and water valves. The vacuum on the under side was caused by allowing cold water to spray into the cylinder after the steam valve to the boiler was closed. The upward stroke was influenced by pressure of steam on the under side of the piston and the weight of the pump rod, mainly by the latter. Although at the present day we observe many imperfections in Newcomen's engine, the latest examples of some types of pumping engines bear traces of the inventor's ingenuity. Humphrey Potter, a boy who attended an engine of Newcomen's, was the first to devise a means of opening and shutting the cocks or valves automatically. This indeed was a wonderful addition when perfected. His first scheme was a catch which engaged in a valve spindle and opened the water inlet immediately the piston was at the top of the cylinder. By this simple invention, which, by the by, Potter, who was quite a boy, thought of in order to allow him to leave the engine and play with his mates*, the speed of the piston was enabled to increase, and sixteen strokes instead of eight were made in a minute.

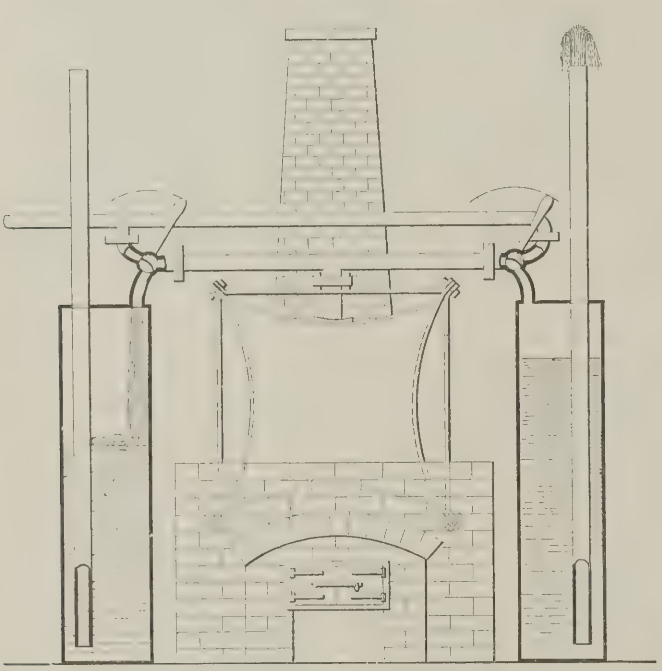
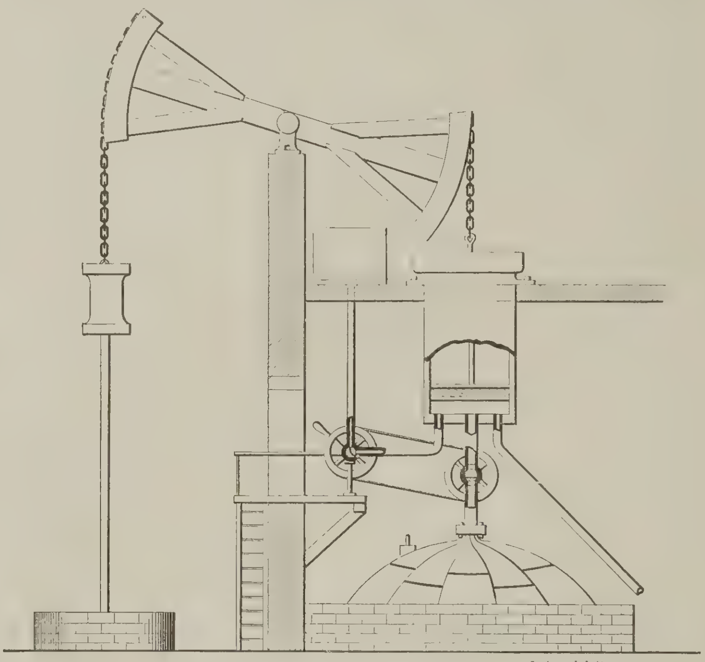


Fig. 2. Marquis of Worcester's Engine.



Industrial Press

Fig. 4. Newcomen's Engine.

By this time other inventors were at work and many patents were registered, especially for improvements in the working of the valves, for it was a common occurrence to have a breakdown through the neglect of the attendant, usually a lad.

John Smeaton in 1767 designed an engine for the New River Company, and he considered that the stoppage of water at every stroke, as well as putting the lever-beam, piston, heavy rods and chains, from a state of rest into motion, twice at every stroke, was a great loss of power; he therefore determined to work the engine slower and with larger pumps, and put upon the piston all the load it would bear. To reduce the velocity of the column of water still more, he placed the fulcrum of the beam out of the center and made the stroke of the piston 9 feet, while the pump, which lifted 36 cubic feet, should work only with a 6-foot stroke. This arrangement obliged him to employ a long narrow cylinder of only 18 inches diameter, and from this he expected to obtain other advantages, viz., that every part of the steam being nearer the surface of the cylinder, would be more readily condensed, and in consequence, that a less quantity of injection water would serve the cylinder, which would itself be more heated. He was disappointed, however, for to his surprise instead of requiring less injection water, it wanted considerably more than engines with shorter cylinders, but of larger diameter. Two men, therefore, had to assist in cooling the cylinder by throwing water on it in order to get the engine to work. It was afterward altered by changing the fulcrum of the beam and reducing the load on the piston. Under the new conditions, although the pump stroke was shortened, the engine worked well and so much quicker as not only to raise more water but burn less coal. Through Smeaton's experience with his first engine he never seems to have made further mistakes. In 1765 this talented engineer made a portable steam engine for drawing foundations, etc. It had a pulley or wheel to pull the chain, which communicated motion from the piston to the pump rod, instead of a beam, and the whole machine was supported in one frame of wood, shaped like the letter V inverted. The boiler required no setting in brickwork, but was in the shape of a large tea kettle, and the fire was in the center of it surrounded on all sides by water.

The next illustration, Fig. 5, represents an atmospheric engine constructed upon Newcomen's principle, under the improvements of Smeaton.

Many were the advances which followed during the next few years, but unfortunately space will not permit of description. We must therefore proceed to the time of James Watt and the experiments he made in 1761. By these experiments Watts made that important discovery of having the steam to do the work on both sides of the piston, and allowing the condensing chamber to be located separately. This was of course the first step toward economy. He found that the loss of steam in alternately heating and cooling the cylinder was not less than three or four times as much as would fill the cylinder and work the engine. Although his means compelled him to employ the simplest and cheapest modes of conducting these experiments, yet the exactness of deductions clearly displays what genius can accomplish under adverse circumstances. Before proceeding, it may be appropriate to allude to a counterclaim of another inventor who suggested a separate condenser. Mr. Hornblower, a rival of Watt, relates that "it occurred to Mr. Gainsborough, a Congregational pastor, and brother to the famous artist of that name, that it would be a great improvement to condense the steam in a vessel distinct from the cylinder, and he undertook experiments to apply the principle he had established." Whether the foregoing is true or not, we must recognize James Watt as the pioneer of the double action steam engine patentees. His originality of thought in this respect has been generally if not universally admitted.

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* This statement is discredited by Henry Davey. See MACHINERY, January, 1904.

For the purpose of undertaking the building of mining engines and plants, Watt joined hands with Bolton, and the firm built many engines for all parts of the world. Many collieries still possess engines built by them, at the Soho Foundry, Birmingham, still working, and likely to remain for another century. The improvements in details of motion, etc., introduced by Watt are too numerous to be dealt with in this article, but as a concluding illustration we give in Fig. 6 a representative engine which possesses many of the contrivances introduced by him. He was the first to employ a flywheel to equalize the motion of the piston, and as it became an important object to convert the alternate motion into a rotary one, he applied his thoughts to another discovery. The crank could have been used, but that was already the subject of a patent for another purpose. He therefore decided upon cogged wheels, and arranged them in a manner shown in the illustration, this being termed the sun-and-planet motion. The governor was introduced by Watt, although the claim to its invention was made by a Mr. Clarke, of Manchester. The expansion engine was the next advance made by Watt. He also designed several types of rotary engines. Great as was the degree of perfection to which the steam engine had been brought by James Watt, the discoveries which he, together with his predecessors had made, furnished abundant materials for the exercise of future ingenuity.

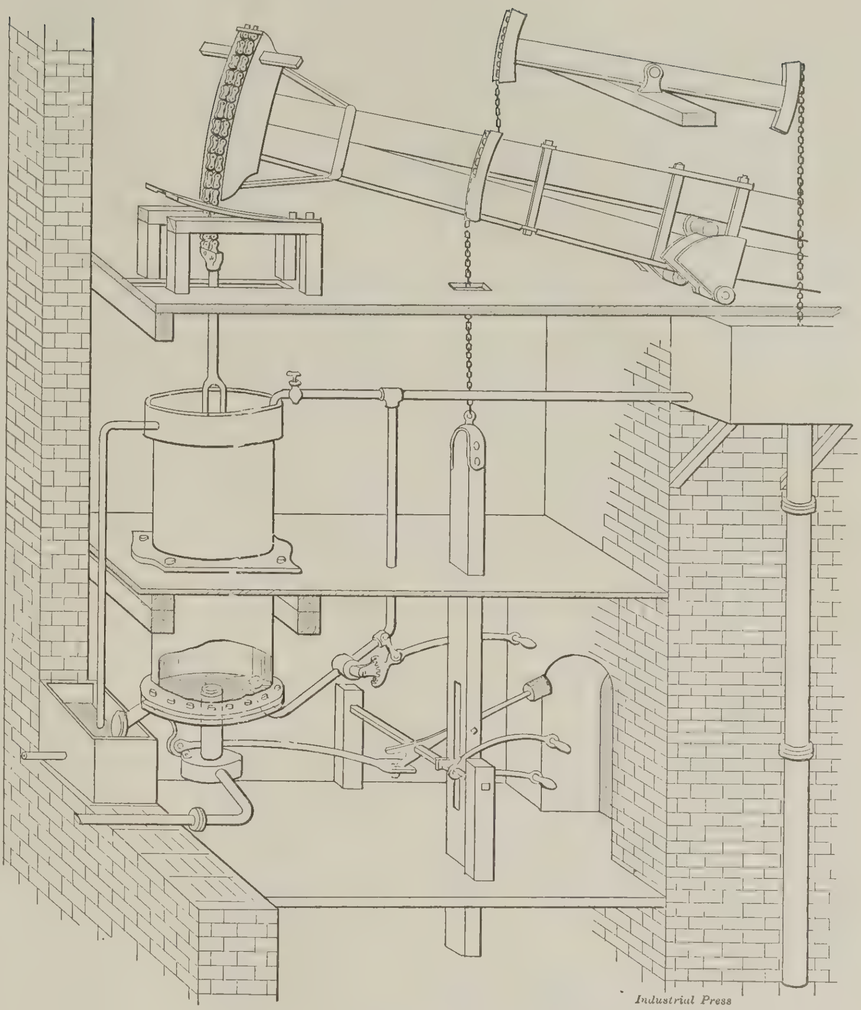


Fig. 5. Smeaton's Engine.

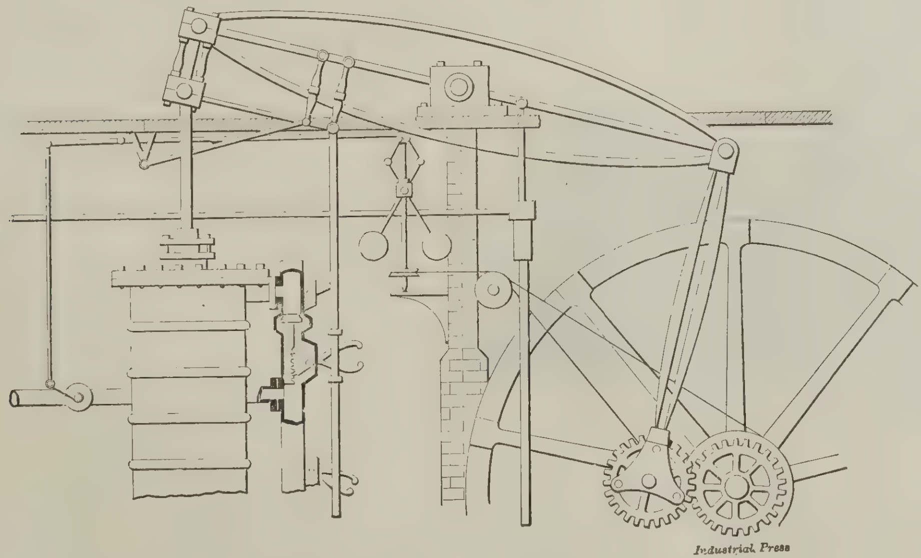


Fig. 6. Watt's Engine.

* * *

The means adopted by the press agent of a big circus for getting free advertising are usually ingenious and not without passing interest, but they are rarely of permanent educational value, to say nothing of being useful to the engineer. An exception, however, seems to be the case in the test of the draft powers of men and animals made in Madison Square Garden recently under the auspices of the ubiquitous "Greatest Show on Earth." In the first trial 100 men on an 80-foot hawser were able to pull only 6,700 pounds, according to a hydraulic pressure gage or dynamometer used for the purpose. Then two draft horses, each weighing 1,700 pounds, were hitched at the end of the hawser. In this position they pulled 2,700 pounds; hitched close to the register they pulled 3,750 pounds. Two more horses of the same weight and hitched to the end of the hawser, pulled 5,125 pounds; close to the register, 5,125 pounds or the same as the two had done. Six horses, each weighing 1,800 pounds, pulled 5,750 pounds at the end of the hawser and 8,875 pounds hitched close up. Two camels (weight not given) pulled 2,750 pounds; a six-ton elephant pushed 4,000 pounds and pulled 8,700 pounds. Two elephants, combined weight 10½ tons, pushed 6,500 pounds besides the resistance of a heavy loaded wagon. The 100 men then pulled 12,000 pounds.

VARIABLE SPEED MOTORS.—3.

WM. BAXTER, JR.

The speed of a motor can be varied in several ways, the simplest of which is by introducing resistance in the armature circuit. This method, although very simple, is very expensive, because the electrical energy used is at all times the maximum amount, the resistance absorbing the portion that the motor does not use. Other methods for obtaining speed variations are arranged so that the electrical energy used is proportional to the power developed by the motor at the time, or nearly so. One way of varying the speed commonly used is by varying the voltage of the current passing through the motor armature. Another way is by varying the current passing through the shunt field coils of the motor, which is accomplished by introducing resistance in this circuit. In compound wound motors the speed is also varied by cutting out the series field coils. By means of the last two methods the speed variation is upward. By the first method the variation is downward, hence with the latter the highest voltage applied to the armature must give the maximum velocity, and with the former the strongest current acting on the field must give the lowest velocity. In some arrangements the field current and armature voltage are both varied, the first to increase the motor speed above the normal and the last to reduce it.

The field current is reduced by the simple process of introducing resistance in the field circuit, but to vary the armature voltage is not so easy. To accomplish the latter result machines called balancing transformers are employed, and by means of these one or more circuit wires are obtained between which and the main lines the voltage is much less than between the mains themselves. Systems of this kind are installed by the Westinghouse, the Bullock and the Crocker-Wheeler companies. In what follows we will describe the Crocker-Wheeler system.

The Crocker-Wheeler Company uses a four-wire system which is obtained by means of a balancing transformer, shown in Fig. 1. This transformer consists of three generators whose armatures are connected in series with each other and directly across the main generator lines in the manner shown in the diagram Fig. 2, in which *G* represents the main generator, *P N* the main line wires, *A B C* the three armatures of the balancing transformers, which are mounted on the same shaft, and *m n* the two supplementary lines derived from the balancer. In this diagram the voltage of the generator is shown to be 240, and the three balancer armatures develop 40, 80, and 120 volts respectively. These three balancer armatures act in precisely the same manner as the armature of a motor; that is, they develop electromotive forces in opposition to the electromotive force of the generator, and as the three combined develop a voltage nearly equal to that of the generator, the current that passes through them when no motors are in use is very small, just enough in fact to furnish the power required to rotate them. The circles numbered from 1 to 8 represent motors connected in the circuit in different ways so as to be subjected to different voltages. A motor connected as at 1 would be acted upon by the voltage balanced by *C*, which is 40. A motor connected as shown at 2, would be subjected to 80 volts, while a motor in position 3, would be subjected to 120 volts. A motor connected as at 4 would be acted upon by the combined electromotive forces of *B* and *C*, which is 160 volts, and if connected as at 5, it would be acted upon by the combined electromotive forces of *A* and *B*, which is 200 volts, while when connected as at 6 it would be acted upon by the main generator electromotive force of 240 volts. Thus it will be seen that with a single generator, and a three-armature transformer, six different voltages can be obtained. These six voltages will give six different motor speeds, and by means of resistance introduced in the armature circuit, six or more intermediate speeds can be obtained.

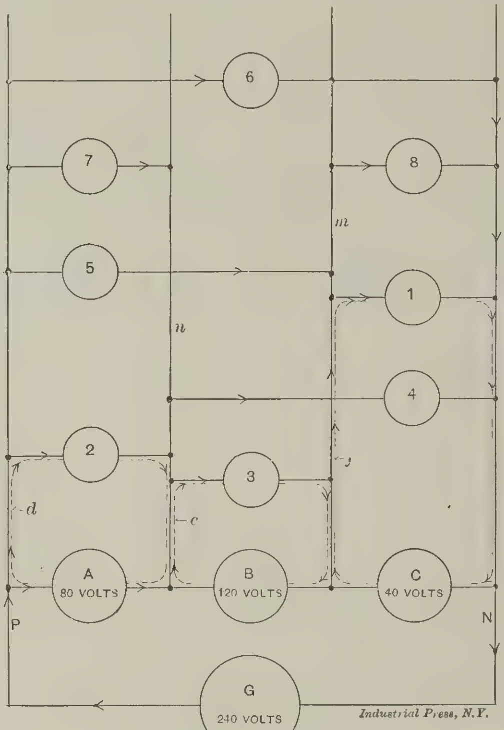


Fig. 1. Diagram of Transformer.

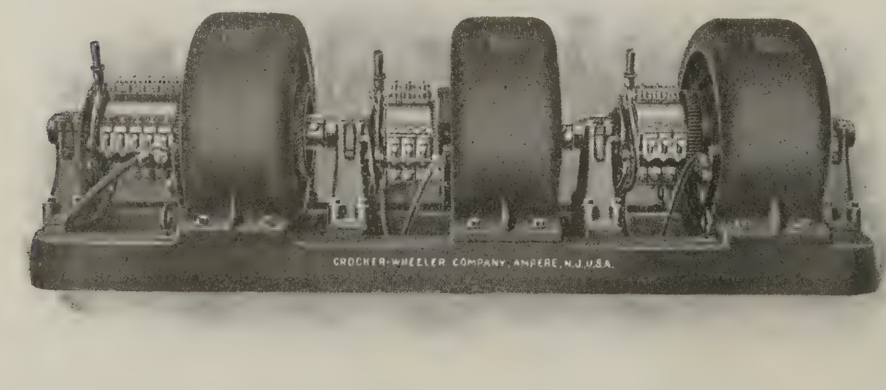


Fig. 1. Balancing Transformer, Crocker-Wheeler Four-wire System.

In operating motors with this system, they are connected as shown by circle 1, when started, and are then passed to positions 2, 3, 4, etc., until the desired velocity is attained.

As the manner in which the currents circulate in a system of this kind is not very generally understood, we will explain the subject briefly. Let us suppose we have a single motor that requires a current of 100 amperes. The question is, where does the current come from when it is connected in the six positions shown, and what portion of the current passes through the transformer armatures *A*, *B*, *C*? When the motor is connected in position 1, a current from the generator *G* will pass through *P*, and through the transformer armatures *A B* to wire *m*, and thus through the motor to line *N*. This current in passing through armatures *A* and *B* causes them to act as motors and the energy developed by them is absorbed in driving *C* as a generator, which develops a current that circulates in the local circuit indicated by line *f* and passes through the motor. Thus the current that actuates the motor is supplied in part by main generator, *G*, and in part by armature *C*. We now desire to know what portion of the current is furnished by the generator, and what portion by armature *C*. To make the explanation as simple as possible we will assume that there is no loss of energy in the transformation, that is, that the electrical energy absorbed by *A* and *B* is equal to that given back by *C*. Making this assumption, the voltage of *C* multiplied by its current must be equal to the product of the sum of the voltages of *A* and *B* multiplied by the current passing through them, so that the two currents must be inversely proportional to the voltages. The voltage of C is 40 and $A + B = 200$; hence, current through A and B is 16.66 amperes, and current through C is 83.33.

When the motor is connected in position 2, armature A acts as a generator, and is driven by B and C. The voltages now are, $A = 80$, $B + C = 160$, current through $A = 66.6$ amperes, which circulates in the circuit d; current through B and $C = 33.3$ amperes. When the motor is in position 3, the armatures A and C act as motors and B is driven as a generator. The voltage of $A + C = 120$ and voltage of $B = 120$, so that the generator current of B will be equal to the current from G that passes through the other two armatures; that is, both currents will be 50 amperes. When the motor is connected in position 4, armature A acts as a motor and B, C, as generators and the strength of currents can be calculated in the manner above explained. In positions 5, A and B act as motors, and C as generator. In position 6 all the transformer armatures act as motors, and require just enough energy to keep themselves in motion, the current passing through them being very small.

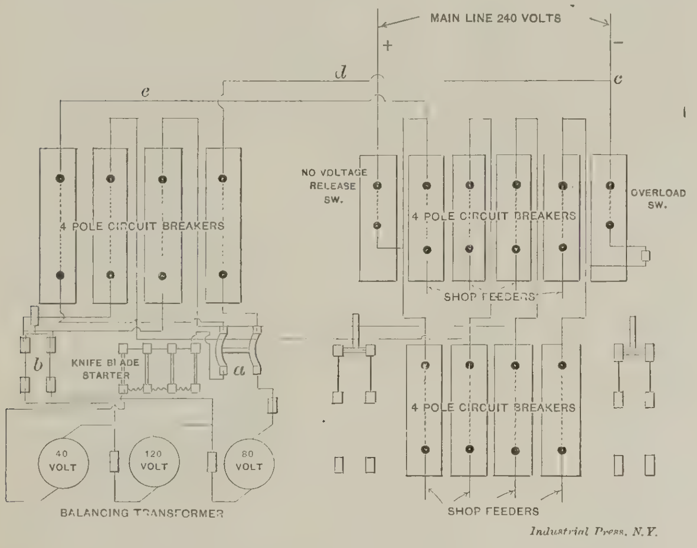


Fig. 3. Showing how Balancer is Connected in the Circuit.

If five motors are in service, and at any instant are connected as shown by circles 1 to 5, each one taking the same amount of current, then 2 will supply current for 4, and 5 will supply current for 1, while the current for 3 will be derived in part from B and in part from G through A and C. If there were two more motors connected, as at 7 and 8, no current would be drawn from A, B, C, for then motors 1, 2, 3, could be regarded as one circuit, while 4, 7, and 5, 8 would form two other circuits, the three circuits being directly across the mains P and N.

From the foregoing it will be seen that the balancing transformer armatures acting as generators provide any excess of current required, above that furnished by the main generator G, between any two wires of the system, the power to generate this current being furnished by the armature or armatures that act as motors at the time.

In the Crocker-Wheeler system the shunt field coils of the motors are connected with the mains P N at all times, and only the armature is changed from one voltage to another. If the field were changed together with the armature, the velocity would change very little.

The diagram Fig. 2 is a simple arrangement of circuits to show the action of the balancing transformer, and does not give a correct idea of the actual way in which the circuits are arranged in a practical installation. In practice it is necessary to provide switches to connect and disconnect the apparatus, circuit breakers to protect against abnormal currents, cut-outs to open the circuit whenever the current fails and save the balancer armature from being burned out if the current is re-established after the balancer has come to a state of rest. In addition suitable switches must be provided to start the balancer, for it must be remembered that this is a machine that acts in the same manner as a motor, and in starting it a resistance must be introduced in the armature circuit to keep the current down within safe limits. After the balancer has run up to normal speed the resistance is cut out and thereafter it runs the same as a motor running free, except when called upon to furnish currents.

The diagram Fig. 3 shows the way in which the balancer is connected in the circuit, and the apparatus used in connection therewith. The mains marked + and — run to the generator terminals. The + line is connected with a circuit breaker that opens the circuit whenever the current fails, or the voltage drops to an abnormal point from any cause. Through this circuit breaker, as shown by the dotted line, the current passes to wire e and thence to a switch a, and through a starting switch to the left side of the balancer. This starting switch is shown in Fig. 4, and is arranged so as to include a number of resistances between its several blades. The — line is connected with an overload circuit breaker, which opens the circuit whenever the current becomes too strong. From the right side terminal of the balancer the current passes to the switch a, and thence to wire d, and to the — line at point c. The foregoing indicates the circuit through the balancer when the circuit breaker directly above it is closed. When the circuit is first closed the balancer is connected with the resistance of the knife blade starter in the armature circuit, and as the blades of this switch are closed one after the other the sections of the resistance are cut out in precisely the same manner as in starting a motor. When the last blade of the starter is closed all the resistance is cut out of the circuit. If now the switch b is closed the intermediate terminals of the balancer, that is, those that connect with wires n and m in Fig. 2 are connected with the intermediate terminals of the shop feeder circuit breakers, which are shown at the right side of cut, Fig. 3. Two of these circuit breakers are shown and each one is connected in a separate set of shop feeders. Thus it will be seen that one four-pole circuit breaker is provided to protect the balancer and in addition circuit breakers are provided for each independent set of shop feeders.

The motors used with this system may be either series, shunt or compound wound, as the case may require. For direct connected machine tools they are generally compound wound. Whatever the winding may be a properly constructed controller must be used to effect the changes in circuit connections required in passing from one voltage to another. The diagram Fig. 5 shows the arrangement of contacts and connections for a controller adapted to a compound wound motor. The motor is shown at the bottom of the diagram. The points marked C, CC, are the terminals of the shunt field coils, those marked S, SS, are the terminals of the series field coils, while A, AA, are the armature terminals.

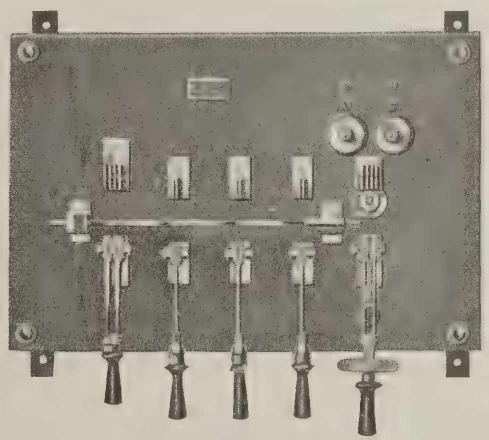
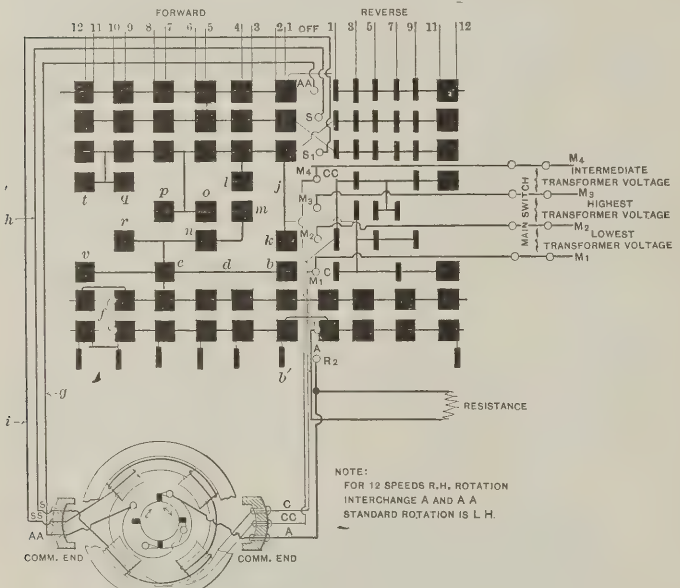


Fig. 4. Starting Switch.

In the upper part of the diagram, which represents the controller, the black squares are contact plates attached to the surface of a cylinder that is arranged to be rotated by hand. The vertical row of small circles marked AA, S, S_1, etc., are stationary contacts so located that they press upon the cylinder contact plates. The four line wires shown at the right and marked $M1$, $M2$, $M3$, $M4$, connect with a set of shop feeders, and by means of a four-pole main switch are connected or disconnected from the controller terminals. As soon as this switch is closed the circuit through the shunt field coils of the motor is closed, the terminals of these coils being connected with the outside lines *M*1 and *M*4, as can be clearly seen by tracing the connecting lines from the stationary controller terminals *C*, *CC* to the similarly marked motor terminals. If the controller cylinder is rotated until the stationary contacts reach the vertical line marked 1, on the left side of the diagram, the motor will start, with the armature and the series coils connected in series with each other and with the lines *M*1 and *M*2, which give the lowest voltage. In this position the starting resistance connected in wire *A* will also be included in series with the armature. The circuit will be as follows: From line *M*1 to stationary controller contact *c*, which will now be resting on *b*. From *b* through wire *d* to *e*, which is connected with the row of cylinder plates below it, as clearly shown. The stationary contacts at *f* connect the two rows of cylinder contacts and thus the current can flow to stationary contact *R*1 and then through the armature resistance to armature terminal *A*, and through the armature to *AA*. From here, by wire *g*, the current passes to the top stationary contact *AA* of the controller, and as the two upper rows of cylinder contacts are connected with each other on the vertical line 5, the current can reach the stationary contact *S*; and then by way of wire *h*, it flows to the terminal *S* of the motor series coils, through these coils to *SS* and thence by wire *i* to S_1 on the controller. From the stationary contact S_1 of the controller, the current passes through connection *j* to cylinder contact *k*, upon which stationary contact *M*2 is resting. Thus the current returns to line *M*2, and the voltage acting on the motor armature is the lowest.



NOTE:
FOR 12 SPEEDS R.H. ROTATION
INTERCHANGE A AND A A
STANDARD ROTATION IS L H.

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Fig. 5. Arrangement of Contacts and Connections for Controller.

When the controller cylinder is rotated further, so that the stationary contacts come on the vertical line 2, all the circuit connections above explained remain unchanged, but in addition the lower stationary contact, *R*2, passes onto cylinder contact, *b*′, and thus the armature resistance is short circuited and the motor speed is increased.

When the controller is rotated until the stationary contacts come on vertical line 3, the stationary contacts *M*1 and *M*2 pass off the cylinder contacts *b* and *k* and stationary contacts *M*3 and *M*4, pass onto cylinder *m l*. This change disconnects the motor armature from the low voltage lines and connects its terminals with the intermediate voltage lines *M*3 and *M*4. Rotating the controller to the vertical line 4 acts as on line 2 to cut out the armature resistance and increase the armature velocity. When the controller is rotated to line 5, the stationary contacts, *M*3, *M*4, pass off of *m* and *l*, and contacts *M*2 and *M*3 ride over *n* and *o*, thus connecting the motor armature with lines *M*2 and *M*3, which give the highest voltage from the balancing transformer.

When the controller is rotated to line 7, stationary contact, *c*, is connected with cylinder contact *e*, and stationary contact *M*3 is connected with cylinder contact *p*, thus connecting the motor armature with lines *M*1 and *M*3, and this gives a voltage equal to the sum of the highest and the lowest. When the controller is advanced to line 9 stationary contact *M*2 rides over cylinder contact *r*, and stationary contact *M*4 rides over *q*, thus connecting the motor armature with lines *M*2 and *M*4, which gives a voltage equal to the sum of the highest and the intermediate. When the controller is advanced to line 11, stationary contact *c* rides over cylinder contact *v*, and stationary contact *M*4 rides over cylinder *t*, thus connecting the motor armature with the outside lines *M*1 and *M*4, which run directly to the generator terminals and give the full voltage of the latter.

From the foregoing it will be seen that by changing the conections between the motor armature and the four line wires six speeds are obtained, and by cutting the armature resistance out for each connection, six other speeds are obtained. The armature resistance is so proportioned that the speed obtained when it is cut out is half way between the speeds obtained by two succeeding voltages. Thus, if the speeds on lines 3 and 5 are 300 and 400, respectively, the speed on line 4 will be 350.

When the controller is rotated in the opposite direction, the motor is reversed. With the construction of controller shown in the diagram, the velocities for the reverse motion are those due to the changes in voltage only, except for the highest speed, obtained on line 12, which is given by cutting out the armature resistance.

A study of this controller diagram will show that in so far as effecting the necessary changes in the circuit connections is concerned, the two upper rows of cylinder contacts could be replaced by a single plate of a size large enough to cover all of them. This is evident from the fact that all these contacts are electrically connected with each other. This is also true of the two lower rows that are connected by the sliding bridge, *f*. A number of contacts are used however, instead of a single plate so as to be able to break the circuit at a number of points when the armature is disconnected from lines of one voltage and connected with other lines of a different voltage, and thereby reduce the sparking to a point where it is harmless. If this construction were not used the sparking would soon burn the controller contacts to such an extent as to render the apparatus practically useless.

* * *

ZINC ALUMINUM ALLOYS.

In a valuable paper on light aluminum alloys read before the American Society for Testing Materials by Mr. Joseph W. Richards at the Delaware Water Gap meeting last July, special reference was made to the valuable characteristics of zinc-aluminum alloys. Zinc is the cheapest and at the same time one of the most efficient of the metals for improving the mechanical properties of aluminum. Proportions up to 33 per cent. of zinc are used, the alloy having this proportion of zinc being known as the "Sibley casting alloy." The zinc-aluminum alloys are malleable up to 15 per cent., and above that, as intimated, are still useful for making castings. Only the purest zinc and the purest aluminum should be used, to get the best alloys. Casting in chills gives much better results than casting in sand; in the latter case the slow cooling seems to cause a separation.

The alloys are made by first melting all the aluminum to be used, in a clean graphite crucible. It is brought a little above melting point so that as the zinc is added, in small pieces, it does not chill the aluminum, but is all absorbed directly as it is added. The melting point decreases as zinc is added, so that if the zinc is added slowly the alloy remains always melted. A wrought-iron rod can be used as a stirrer, if the heat does not at any time go above low redness. The metal should be poured as cold as is practicable; when much hotter than its melting point it is not so thinly fluid as when somewhat cooler. The crucible should be kept covered while melting the aluminum, and no charcoal or flux put into the crucible, except, possibly, a little salt.

The alloy with 15 per cent. zinc can be rolled and drawn. In chill castings it has an elastic limit of 16,000 pounds per square inch, tensile strength 22,330 pounds, elongation 6 per cent. in two inches, and reduction of area 10½ per cent. The alloy with 25 per cent. zinc has a tensile strength of 22,000 pounds, extension 1 per cent., and reduction of area 3 per cent., when cast in sand. When cast in chill-molds its tensile strength is 35,000 to 45,000 pounds, extension 1 per cent., with a close fracture like high-carbon steel. Its specific gravity is 3.4, which shows a contraction of 14 per cent. in the bulk of the constituents while alloying, and since 1 part of zinc has only one-eighth the volume of three parts of aluminum, the remarkable conclusion follows that the aluminum takes up one-third of its weight of zinc and actually decreases in volume some 2 per cent. in doing it. This probably accounts for the close grain and good working qualities of this alloy. It is non-magnetic, has a fine color, takes a high polish, and bids fair to be the most generally useful of all the light aluminum alloys.

* * *

STRAIGHT AND CIRCULAR FORMING TOOLS.

JOS. M. STABEL.

Jos. M. Stabel.

Almost every machinist who is engaged in tool work will have more or less to do with the making of forming tools. These may be used for shaping sheet metals, or for use under the drop hammer, or again, they may be employed in the lathe, planer, shaper or milling machine. It is the object of the present article, however, to confine ourselves to a description of the straight and circular forming tools that are so universally used on screw machines. For certain purposes these tools need not be of a very exact nature, while again, they require great accuracy in their construction as they are to be used for the manufacture of interchangeable parts. As the old saying goes: "It is easy enough to make one alike," but when it is necessary to make duplicate tools it is quite a difficult task.

While there are numerous methods employed for making these tools, the writer has never seen one described which will enable the machinist to compute the distances, diameters or angles so as to produce the required dimensions on the finished work. If, for instance, a circular tool is to produce certain diameters on the work, and we transfer the exact ratio of these different diameters from the drawing to the forming tool, we will not be able to get the required dimensions when the cutting edge of the tool is one-quarter of an inch below the center. If we have to make a straight forming tool which, in the machine, is to stand at an angle of 15 degrees, we can, when it is not very wide, avail ourselves of the use of a master forming tool. When, however, the tool is very wide, so that the use of the master tool is unpractical, and it is necessary to mill or plane it to shape, some computation is then necessary in order to make the shape such that it will produce tho required dimensions on the work when the tool is held at an angle in the machine.

We will first consider a method of making straight forming tools which has proved satisfactory and will produce accurate results if properly manipulated. We will suppose that we are called upon to make the tools for producing with accuracy such a piece of work as shown in Fig. 1, and that a master former is to be made so that at any future time the forming tool can be duplicated at small expense. The master former will be made as in Fig. 2, being an accurate duplicate of our model with the addition of a shank about an inch and a half in length on each end, these shanks serving as an arbor for the tool.

The formed part is then milled down to the center, to produce a cutting face for future operations, after which it is hardened, tempered and the face accurately ground.

To facilitate this face grinding the fixture shown in Fig. 3 is employed, the work being done on a surface grinder. The most essential point to be observed in grinding such a former is to have the cutting face radial, and this is accomplished by the use of this fixture. The fixture is placed on the grinder so that the line of centers is at right angles with the emery wheel; the center *c* is removed from the block *d* and the emery wheel is brought to bear on the ball *b*, which is a running fit in the lever *a*. This lever is fulcrumed on the block *d* and is held upward by means of a spring attached to the short arm. With the emery wheel at rest, the table of the grinder is now run back and forth and the wheel fed downward until it reaches such a position that when it is passed over the ball *b* the front end of the lever will indicate zero. This shows the operator that the periphery of the wheel is in perfect alignment with the center of the fixture. The center *c* is then replaced and the master former, with dog attached, is placed between the centers and ground. By the use of the handle *e*, which engages the adjustable center, the former is turned slightly after each cut across the face until a keen cutting edge on the same is obtained.

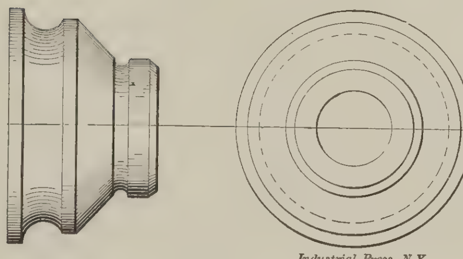

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Fig. 1.

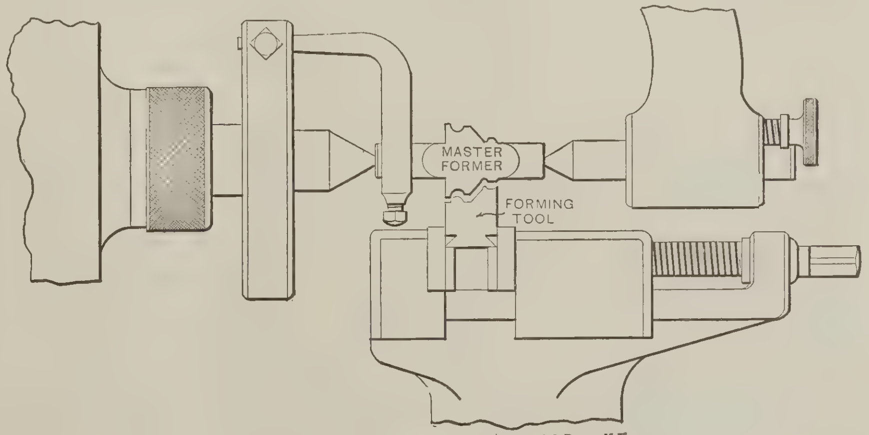

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Fig. 4.

The block from which the forming tool is to be made is placed in the vise of the milling machine and roughed out as near to the formed shape as possible, after which the master former is substituted for the milling cutter, as shown in Fig. 4. The cutting face must stand at the same angle with perpendicular as the forming tool is to stand when placed in the screw machine, and it is very essential to observe this point if accurate results are desired. When the proper angle of the former has been obtained it is secured in position by a wooden wedge tapped in between the cone and the frame of the milling machine and the table is then run back and forth until the forming tool is cut to the desired shape.

If an extra long forming tool is required, say eight or nine inches in length, and it is desired to prolong the life of the master former, we would then make use of a second master

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former, constructed as previously described for the forming tool. This second master former fits into a holder, as shown in Fig. 5, and when it is being formed should be held at right angles with the bed of the machine. It is then necessary to make a similar piece to be used for making the working formers. To avoid confusion we will call this first piece No. 1 and the next piece to be made No. 2. This second piece must have the form of No. 1 transferred to it and for this purpose it is placed in the block shown in Fig. 6, which holds it at an angle of 10 degrees with the shaper vise. Piece No. 1, in its holder, is placed in the toolpost of the shaper where a tapered block holds it at a corresponding angle with piece No. 2, so that their faces are in line, as shown in Fig. 7. By locating these pieces in this way the form of No. 1 can be accurately transferred to No. 2, at the same time giving No. 2 the required clearance so that it can then be held squarely in the shaper toolpost and used to shape the forming tools that are held in the shaper vise at an angle of 10 degrees.

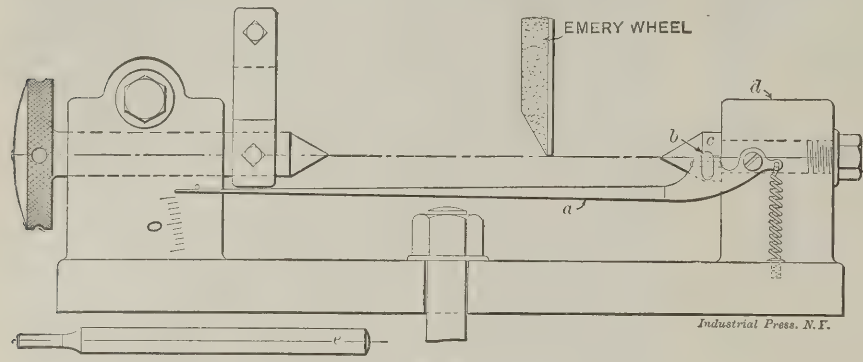

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Fig. 3.

To make this last method clear we must bear in mind that at whatever angle the forming tool stands when in the screw machine, this angle must be maintained for setting the face of the master former. This transfers the form to No. 1 and overcomes the discrepancy caused by the tool standing at an angle in the screw machine, and this when in turn transferred to No. 2 gives it the clearance required and the exact shape of No. 1.

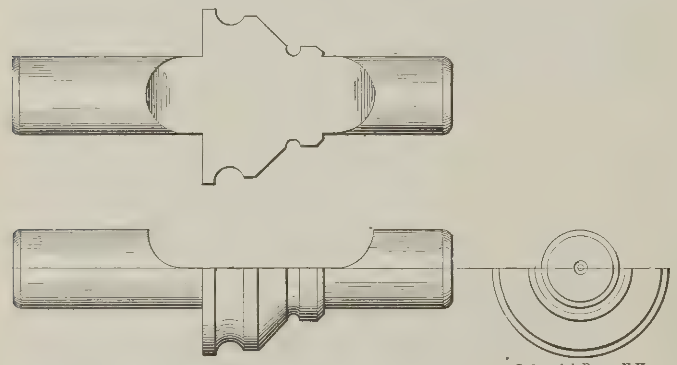
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Fig. 2.

[There are numerous other methods in use for accomplishing this class of work and some, no doubt, may be simpler, but they do not yield such accurate results. One of these methods consists in filing a templet to fit the model and from this making the shaping tool, which in turn is placed in the shaper with the face standing at the same angle as will the forming tool when placed in the screw machine. Then the forming tool blank is put in the vise and shaped up in the usual way.

The foregoing methods have all been based upon the duplication of the formers by mechanical means, but we will now consider other methods in which the dimensions of the formed tool are computed from the ratios of the different diameters on the work. We have already made it clear that an error will exist if we transfer to the tool the exact differences in the various radii on the work, and it is to overcome this error that we subtract from the dimensions of the work such differences as are caused by the tool standing at an angle in the machine.

As will be readily seen in the figure at the head of Table I., the line $a\ c$ is always larger than $b\ c$ and as $a\ c$ must be equal to the difference between two radii on the work, $b\ c$ will consequently equal $a\ c \times$ cosine of the angle at which the tool is to rest in the machine. Table 1 is arranged to facilitate the computation of the tool dimensions to give required dimensions on the work. In the first column is given the distance $a\ c$, or the actual cutting distance; and the second, third and fourth columns give corresponding distances $b\ c$ when the tool is to stand at an angle of ten, fifteen or twenty degrees in the machine.

To illustrate the use of this table we will take as an example the piece shown in Fig. 8, the respective diameters of which are 1.75 inch, .75 inch and 1.25 inch. We will first reduce these diameters to their respective radii, which equal .875, .375 and .625. Now the difference between the first and the second is .500, which would equal the actual cutting edge on the tool, or $a\ c$. Referring to our table we find in the first column our distance $a\ c = .500$, and if the tool is to set at an angle of 15 degrees we find our corresponding value for $b\ c$ in the third column; $b\ c = .482965$. In the same way we find our second step which, for a difference in radii of .25, equals .193186 + .048297 = .241483. If we then plane our forming tool so that the steps will measure .4829 and .2415 respectively, when this tool is placed in the machine with the cutting face perfectly central with the work, and the front face at an angle of 15 degrees, the diameters turned will correspond to those in the sketch.

It often happens that an angle is to be turned upon the piece and this angle will naturally change when the tool is placed at an angle. Table 2 has therefore been computed to give the angle that is to be made on the tool for obtaining a required angle on the work. The angles given are measured from the center line of the piece or, what is the same thing, with the formed face of the tool. Thus in Fig. 8 we have an angle of 45 degrees and as the forming tool will rest at an angle of 15 degrees in the machine, we refer to the third column of Table 2, where we find 44 degrees as the proper angle for the tool and if the tool is made to this angle it will cut the work to the 45 degrees required. The angular difference, as will be seen, is the greatest at 45 degrees, from which it decreases at about the same rate toward zero and 90 degrees.

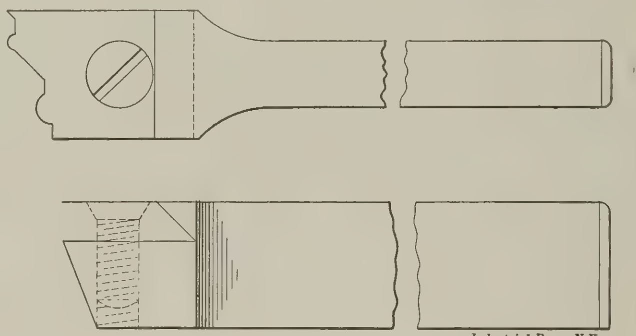
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Fig. 5.

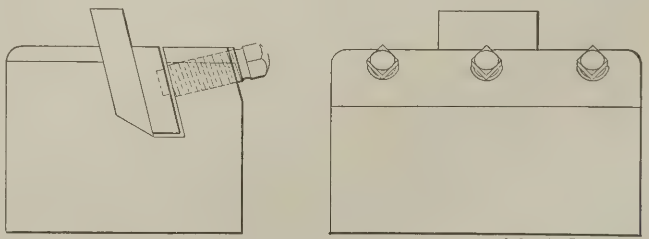
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Fig. 6.

Circular forming tools are used in the same capacity as straight ones and to make them accurately entails quite a little computation. Whenever a circular tool has two or more diameters a discrepancy will exist between the different diameters on the tool and on the work, if the cutting face is below the center of the tool; and table No. 3 has been computed to show these discrepancies and to assist in determining the proper

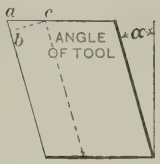


TABLE NO. 1. USED IN MAKING STRAIGHT FORMING TOOLS.

$a\ c$ = Actual Cutting Distance.	$b\ c$ Angle of Tool 10°	$b\ c$ Angle of Tool 15°	$b\ c$ Angle of Tool 20°
.001	.000985	.000966	.000940
.002	.001970	.001932	.001879
.003	.002954	.002898	.002819
.004	.003939	.003864	.003759
.005	.004924	.004830	.004699
.006	.005909	.005796	.005638
.007	.006894	.006762	.006578
.008	.007878	.007727	.007518
.009	.008863	.008693	.008457
.010	.009848	.009659	.009397
.020	.019696	.019319	.018794
.030	.029544	.028978	.028191
.040	.039392	.038637	.037588
.050	.049241	.048297	.046985
.060	.059089	.057956	.056381
.070	.068937	.067615	.065778
.080	.078785	.077274	.075175
.090	.088633	.086934	.084572
.100	.098481	.096593	.093969
.200	.196962	.193186	.187938
.300	.295443	.289779	.281907
.400	.393924	.386372	.375876
.500	.492405	.482965	.469845

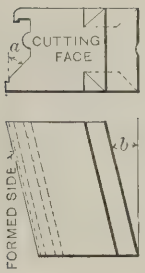
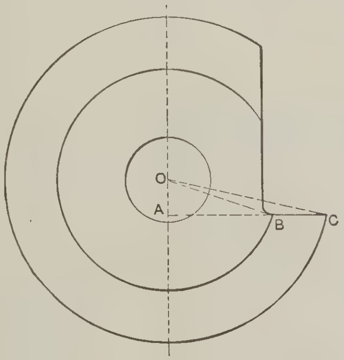


TABLE NO. 2. COMPUTED ANGLES ON STRAIGHT FORMING TOOLS.

a = Angle on Cutting Face of Forming Tool.	Angle Measured on Formed Side, which coincides with Angle A on Cutting Face, when Forming Tool stands at 10, 15 or 20 degrees from Perpendicular.		
	b = 10 degrees.	b = 15 degrees.	b = 20 degrees.
5°	4° — 55′	4° — 50′	4° — 42′
10	9 — 51	9 — 40	9 — 24
15	14 — 47	14 — 31	14 — 08
20	19 — 43	19 — 22	18 — 53
25	24 — 40	24 — 15	23 — 40
30	29 — 37	29 — 09	28 — 29
35	34 — 35	34 — 04	33 — 20
40	39 — 34	39 — 01	38 — 15
45	44 — 34	44 — 00	43 — 13
50	49 — 34	49 — 01	48 — 14
55	54 — 35	54 — 04	53 — 18
60	59 — 37	59 — 08	58 — 26
65	64 — 40	64 — 14	63 — 36
70	69 — 43	69 — 21	68 — 50
75	74 — 47	74 — 30	74 — 5
80	79 — 51	79 — 39	79 — 22
85	84 — 55	84 — 49	84 — 41

TABLE NO. 3. FOR COMPUTING DIAMETERS OF CIRCULAR FORMING TOOLS.

OC = Radius of forming tool.
OB = Second radius of forming tool.
OA = Distance from center to cutting face of tool.
$AB = \sqrt{OB^2 - OA^2}$
$BC = \sqrt{(OC^2 - OA^2)} - \sqrt{(OB^2 - OA^2)}$



Diameter of Tool = 2 O C	Radius of Tool = O C	CUTTING FACE ⅛″ BELOW CENTER.				CUTTING FACE 3/16″ BELOW CENTER.				CUTTING FACE ¼″ BELOW CENTER.				CUTTING FACE 5/16″ BELOW CENTER.			
		A C	Correction for ⅛″ Difference in Diameter.	Correction for ¼″ Difference in Diameter.	Correction for ½″ Difference in Diameter.	A C	Correction for ⅛″ Difference in Diameter.	Correction for ¼″ Difference in Diameter.	Correction for ½″ Difference in Diameter.	A C	Correction for ⅛″ Difference in Diameter.	Correction for ¼″ Difference in Diameter,	Correction for ½″ Difference in Diameter.	A C	Correction for ⅛″ Difference in Diameter.	Correction for ¼″ Difference in Diameter.	Correction for ½″ Difference in Diameter.
1	.500	.48412	....	....	....	.46351	......	......	......	.43301	......	......	......	.39031	......	......	......
1⅛	.5625	.54843	.00362	....	....	.53033	.00864	......	......	.50389	.01676	......	......	.46771	.02980	......	......
1¼	.625	.61237	.00288	.00650	....	.59621	.00676	.01540	......	.57282	.01286	.02962	......	.54126	.02210	.05190	......
1⅜	.6875	.67604	.00234	....	....	.66143	.00544	......	......	.64044	.01024	......	......	.61237	.01722	......	......
1½	.750	.73951	.00194	.00428	.01078	.72618	.00450	.00994	.02534	.70710	.00832	.01856	.04818	.68179	.01384	.03106	.08296
1⅝	.8125	.80282	.00162	....	....	.79056	.00376	......	......	.77308	.00696	......	......	.75000	.01142	......	......
1¾	.875	.86602	.00140	.00302	....	.85467	.00322	.00698	......	.83852	.00588	.01284	......	.81729	.00958	.02100	......
1⅞	.9375	.92112	.00120	....	....	.91855	.00276	......	......	.90355	.00506	......	......	.88388	.00818	......	......
2	1.000	.99215	.00106	.00226	.00528	.98226	.00242	.00518	.01216	.96825	.00440	.00946	.02230	.94991	.00706	.01524	.03624
2⅛	1.0625	1.05512	.00094	....	....	1.04582	.00212	......	......	1.03267	.00384	......	......	1.01550	.00618	......	.....
2¼	1.125	1.11803	.00082	.00176	....	1.10926	.00188	.00400	......	1.09687	.00340	.00724	......	1.08072	.00544	.01162	......
2⅜	1.1875	1.18090	.00074	....	....	1.17260	.00168	......	......	1.16086	.00294	......	......	1.14564	.00484	......	..
2½	1.250	1.24370	.00066	.00140	.00316	1.23580	.00150	.00318	.00718	1.22475	.00278	.00572	.01296	1.21032	.00436	.00920	.02082
2⅝	1.3125	1.30653	.00060	....	....	1.29904	.00138	......	......	1.28847	.00244	......	......	1.27475	.00386	......	.....
2¾	1.375	1.36930	.00054	.00114	....	1.36215	.00122	.00260	......	1.35208	.00222	.00466	......	1.33901	.00352	.00738	......
2⅞	1.4375	1.43205	.00050	....	....	1.42521	.00112	......	......	1.41559	.00202	......	......	1.40312	.00322	......	......
3	1.500	1.49478	.00046	.00096	.00210	1.48823	.00104	.00216	.00476	1.47902	.00186	.00388	.00854	1.46708	.00292	.00614	.01352
3⅛	1.5625	1.55749	.00042	....	....	1.55120	.00094	......	......	1.54237	.00170	......	......	1.53093	.00270	.....	......
3¼	1.625	1.62018	.00038	.00080	....	1.61414	.00088	.00182	......	1.60565	.00156	.00326	......	1.59466	.00246	.00516	......
3⅜	1.6875	1.68286	.00036	....	....	1.67705	.00082	......	......	1.66883	.00144	......	......	1.65831	.00230	....	......
3½	1.750	1.74553	.00034	.00070	.00150	1.73992	.00074	.00156	.00338	1.73205	.00136	.00280	.00606	1.72187	.00212	.00442	.00958
3⅝	1.8125	1.80818	.00032	....	....	1.80277	.00070	......	......	1.79518	.00126	......	......	1.78535	.00196	.....	......
3¾	1.875	1.87082	.00028	.00060	....	1.86560	.00066	.00136	......	1.85826	.00116	.00242	......	1.84877	.00186	.00382	......
3⅞	1.9375	1.93346	.00026	....	....	1.92840	.00060	......	......	1.92130	.00108	......	......	1.91213	.00172	....	.....
4	2.000	1.99608	.00024	.00050	.00100	1.99119	.00058	.00118	.00254	1.98431	.00102	.00210	.00452	1.97543	.00160	.00332	.00714

diameters of formed tools to give required diameters on the work. The first and second columns give the diameters and radii respectively of the formed tools, while the third column gives the distance from the vertical center line of the tool to these radii when the cutting face is ⅛ inch below the horizontal center line. The next three succeeding columns give the constants that are to be used in computing the various diameters of the forming tools when the cutting face is ⅛ inch below the horizontal center line, as will be made clear in the example following. In the remaining columns are tabulated similar values for these, for use when the cutting face of the tool is 3-16, ¼, and 5-16 inch below the horizontal center line of the tool. As there is no standard distance for the location of the cutting face the table has accordingly been prepared to correspond with such distances as are most commonly used.

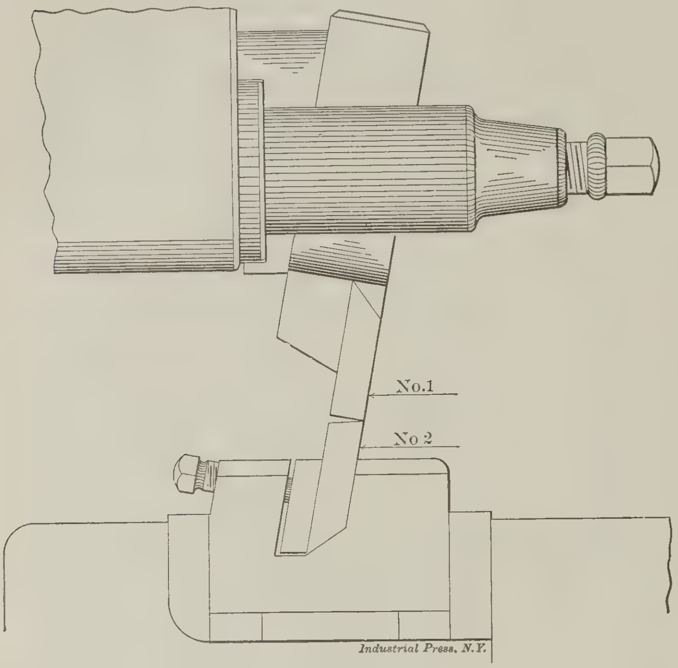


Fig. 7.

As an example illustrating the use of these tables we will consider that we are to make a circular forming tool for the piece shown in Fig. 8, and that the largest diameter of the tool is to be 3 inches, and its cutting face ¼ inch below the horizontal center line. The first step will be to determine approximately the respective diameters of the forming tool and then to correct them by the use of the tables.

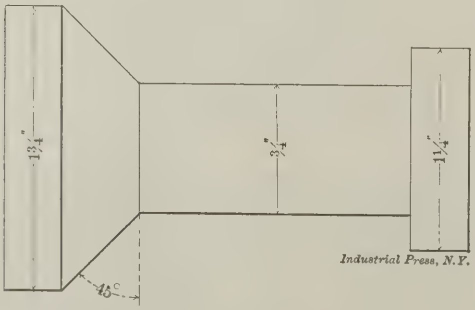


Fig. 8.

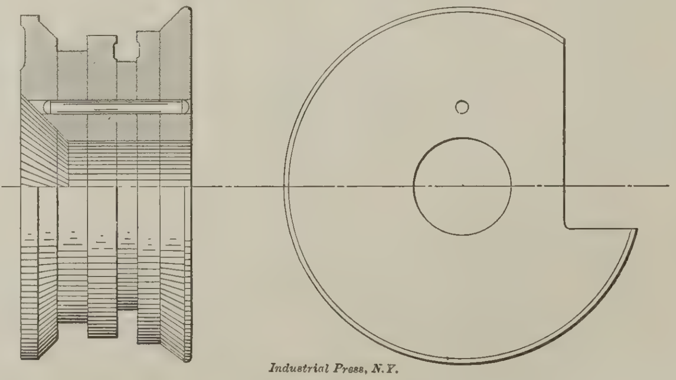


Fig. 9.

The diameters of the piece are 1.750, .750 and 1.250 respectively, and to produce these with a 3-inch cutter the diameters of the tool would be approximately 2.000, 3.000 and 2.500 inches respectively. The first dimension, 2.000, is 1.000 in diameter less than the diameter of the tool, and for the correction we would look in the column of differences for inches, but as the tables are only extended to half inches we will be obliged to obtain our correction in two steps. On the line for 3-inch diameter, and under corrections for ½ inch, we find .00854; and then on line of 2½, and under the same heading, we find .01296, consequently our total correction would be .00854 + .01296 = .02150. This correction is added to the approximate diameter, making the exact diameter of our first step 2.000 + .02150 = 2.02150 inches. Our next step would be computed in the same way by noting on the 3-inch line the correction for ½ inch and adding it to the approximated diameter of our second step, giving us an exact diameter of 2.500 + .00854 = 2.50854. Thus our tool to produce the piece shown in the example would have three steps of 2.0215, 3.000 and 2.50854 inches respectively if it is to have its cutting face ¼ inch below center. All diameters are computed in this way, from the largest or fixed diameter of the tool.

In conclusion, the writer would call the reader's attention to the formed tool, illustrated in Fig. 9, which is made in sections so that all diameters, sides and angles can be easily ground after the tool is hardened. This design is of especial value when such tools are made from high speed steel, as the finished surfaces are likely to be roughened by the high heat that is necessary for hardening.

* * *

COMPRESSED AIR AS AN INSULATOR.

The transmission of electrical power economically over long distances is limited only by the permissible voltage and cross-section of the conductor, and the insulation. Leaving out consideration of the leakage at the insulators, the voltage is inversely proportional to the cross-section of the conductor for the same efficiency of transmission. That is, given two power transmission lines of equal length, one working at 50,000 volts and the other at 5,000 volts, the cross-section of the 5,000-volt line must be ten times the area of that of the 50,000-volt line in order to work at the same efficiency. But copper costs money, and on a long-distance line, large section conductors are prohibitive. Hence the general use of high voltage. Unfortunately 60,000 to 100,000 volts is about the limit of high-voltage transmission, and these extreme figures are possible only where the atmospheric conditions are favorable. Were a 1,000,000-volt transmission line possible and practicable, the driving of the wheels of New York City by the power of Niagara Falls would be an assured fact. In an article, "Some Problems in Electrical Engineering," by Mr. Harris J. Ryan, which appeared in the April issue of the *Sibley Journal*, the author referred to this limiting condition of long-distance power transmission, but showed that while air at atmospheric pressure acts as an insulator up to a certain voltage limit, this voltage limit increases with air pressure, the increase being almost directly proportional to the increase of pressure up to about 125 pounds per square inch. At 150 pounds pressure, air has *ten times* the insulating strength of that at atmospheric pressure. While this fact could scarcely be expected to affect the future of long-distance transmission outside the power house, it is pointed out that it may be of considerable value in the construction of high-voltage apparatus. Thus the static transformer would be a fair field. The oil-insulated transformer is a serious fire risk and is expensive. The use of compressed air would obviate the fire risk and give equal or better insulation at moderate pressures. Cooling could be effected by circulating the compressed air over water pipes, etc.

* * *

Some one has defined engineering as applied common sense, and an engineer as a person who, for one dollar, can do what any man can do with two dollars.

TOOL MAKING.—7.

SCREW THREADING DIES.

E. R. MARKHAM.

Machine screws and bolts are ordinarily threaded by means of dies. To distinguish this form of die from the various other forms in use, they are termed screw threading dies. Names are also given to the various styles of screw threading dies, to distinguish them from one another. These names denote the form, or some characteristic of the die. Square dies are so named because they are square in shape, Fig. 1, and are commonly used for threading bolts and pipe, but the dies for bolts are made differently from those used for threading pipe. Round dies, sometimes termed "button" dies, Fig. 2, are made solid and adjustable. The solid die is used where exactness of size is not essential or for roughing a thread which is to be finished with an adjustable die. Adjustable dies, as their name denotes, are adjustable, and their size can be altered to compensate for wear, or for any desired alteration in size of screw being threaded. In the inserted blade dies, Fig. 3, the cutting edges are blades which are inserted in the body of the die. Spring dies, or hollow mill dies as they are called in some shops, are shown in Fig. 4. Self-opening dies are used when cutting long threads. When the die has cut a screw the desired length, the cutting edges recede from the work, obviating the necessity of backing off the die. Thus for work on long screws valuable time is saved, and the tendency of the die to alter the shape of the thread when backing off is done away with.

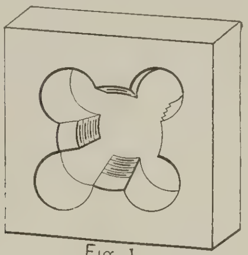


Fig. 1

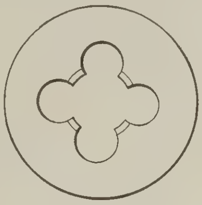


Fig 2

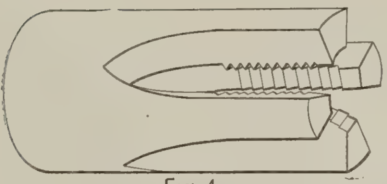


Fig. 4

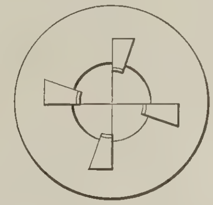


Fig 3
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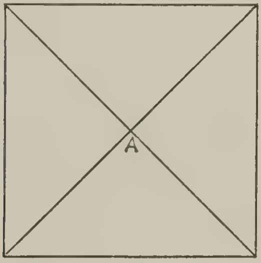

Fig. 6

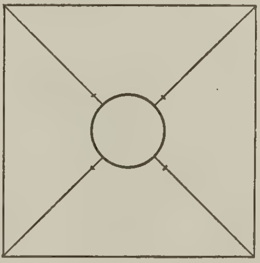
Fig. 7
Industrial Press, N. Y.

There are many forms of this die, and to attempt a description of all of them would be out of the question; we will consider one of the simplest. This form, however, is not claimed to be the most satisfactory when in use, but some dies on the market which give excellent results are made for the trade, in shops equipped with special tools which render it impossible with the ordinary machine shop equipment to make a die at anywhere near the figure they can be purchased for. While the self-opening die shown in Fig. 5 is not claimed as the best, it works very nicely, and is commendable because it can be made in the ordinary shop, by the ordinary man.

The cutting edges are located on the ends of two movable jaws, or sliding pieces; these are placed in a slot cut in the head. They are moved toward the center by means of inclined cuts in the ring, as shown. To open the die turn the ring to allow the end of sliding pieces to go into the deepest part of the inclined cut. A spring in each slide forces them against cut in ring. The ring *B* is made to fit on body *A*, which contains the slot to receive the movable jaws *C C*. These are kept in place by means of the plate *D*.

The length of the threaded portion of screw is governed by the location of the dog *E*, which is movable on and fastened to the plunger *F*. The dog projects through a slot to the hole in shank, making it possible for the screw to strike it, thus forcing the plunger out of hole in the adjustable ring *G*. This ring is adjustable on head ring *B* and is fastened to it by means of setscrew *H*, which adjustment is necessary in order to alter the cutting size of die. Plunger *F* is movable through collar *I*, which is securely fastened to the head by means of a pointed setscrew, as shown. A coil spring forces the plunger into the hole in the adjustable collar *G*, when it is turned to a position that insures the die cutting the correct size.

The movable pieces *C C* are moved toward the center by means of the inclined surfaces on inner side of ring *B*. When the plunger is forced out of the hole in collar *G* the springs acting on the sliding pieces *C C* force them against the inclined surfaces in outer ring causing it to turn, thus allowing the die to open.

The operations required for making this tool are similar to those described for other tools, so it does not seem necessary to go into detail, except in regard to the method of machining the inclined surfaces on inner portion of ring. The outer face of ring is colored with blue vitriol solution lines laid out showing the location of the desired surfaces, which may be machined by several different methods. The particular method depends on the facilities at hand. A hole is drilled at the deepest portion of the incline. The ring is fastened to the faceplate of the lathe in the proper position to insure the desired location of the proposed surface. Now by means of the proper tool the necessary stock may be removed. It will be necessary to turn the lathe spindle by hand and only far enough to allow the tool to pass into the drilled hole; or the ring may be held in the vise on the universal milling machine and then by means of a small cutter the stock may be removed. It will be necessary to follow the lines by means of the various hand feeds of the machine. If the machine has a vertical spindle milling attachment it will be found much easier to follow the lines than if the cutter is held in the horizontal spindle. If milling machine has a rotary milling attachment the ring can be located so the cutter will follow the lines without operating the longitudinal or cross feeds. The cutting could also be done in a profiling or a die sinking machine.

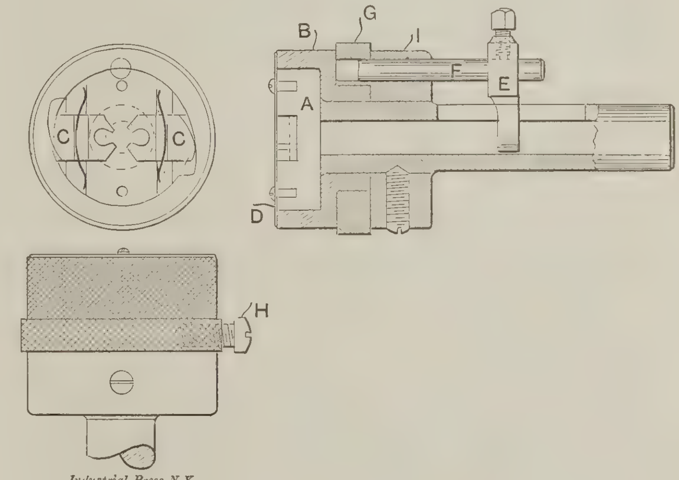

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Fig. 5

Square Die. This form of die is generally used in machine shops for threading bolts, and for this purpose is placed in a bolt cutter. When making square dies the blank is planed to size and thickness, which must correspond to the size of opening in the holder which receives the die. The center of the face is found by scribing lines from opposite corners, as shown in Fig. 6, the center being where the lines intersect. Before scribing these lines, however, the face of the die should be colored in order that any lines made on it may be readily seen. This may be done by applying the blue vitriol solution, or the blank may be heated sufficiently to show a distinct straw color or blue. Having scribed the lines from opposite corners, prick-punch the face where the lines intersect. Before drilling and tapping the die lay out and prick-punch for the clearance holes. It is necessary to have clearance holes in order to provide cutting edges; and they also serve as receptacles for the chips removed when the die is cutting.

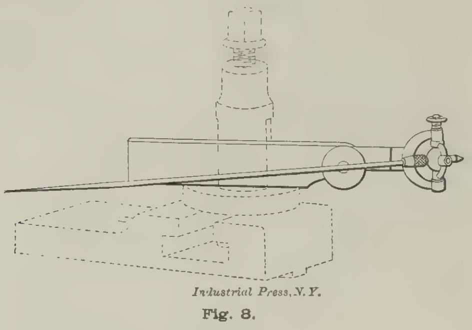
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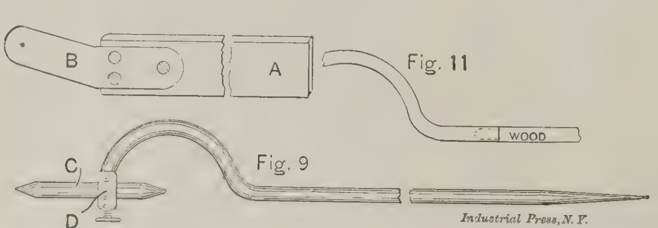
Fig. 8.

The distance of the centers of the clearance holes from the center of the die must be in accordance with the practice in the shop where the work is done. In some shops it is the rule to have the center one-half the diameter of the screw to be cut distant from the center of the die. If this rule is followed the clearance holes are too small to allow a reasonable amount of chips to be retained without so filling the holes as to tear the tops of the thread being cut. Then again it is necessary to lay out the clearance holes on the back of the die after the thread has been cut, and the hole filled with a screw which fits *tightly* in the threaded hole. Generally speaking, it is advisable to lay out the clearance holes further from the center than the distance mentioned, and therefore it is practical to lay them off after finding the center. A circle may be scribed the proper distance from the center of the die and where it intersects the lines drawn across corners we may prick-punch for centers of clearance holes. Experience has convinced the writer that best results are obtained if the outline of the die is laid out on a piece of sheet steel whose surface is colored either with the solution—blue stone—referred to, or by heat. Many toolmakers prefer using a piece of sheet brass, or zinc, for this purpose. After scribing the hole in center of die we can lay out the clearance holes, making the lines light until we have them located right, as shown in Fig. 7.



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When ready to drill and thread the die the blank may be clamped to the faceplate of the lathe, truing it by means of the center indicator, shown in Fig. 8. The indicator plays such an important part in the production of accurate work that it seems wise to give a brief description of it, and of some of the uses to which it may be put.

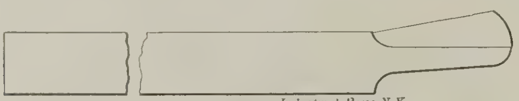
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Fig. 10.

Indicators may be purchased which give excellent satisfaction; but the young mechanic very often prefers, as far as possible, making such tools as he can, and he certainly takes greater pride in the product of his skill than in anything he can buy, even should the material bought and the time lost amount to more than the cost of a tool he may buy. An excellent indicator and one that is easily made is illustrated in Fig. 9. This consists essentially of a shank, which may be made of a size of steel that readily enters the toolpost slot of any lathe likely to be used. If tool steel of the proper size can be easily obtained, and no machine steel can be procured that does not need machining, it will be cheapest to use the tool steel; but machine steel answers the purpose as well, and is much cheaper, when the right size can be had.

If a surface grinder is at hand the surfaces of the shank *A* may be ground square with each other. When stock larger than the desired size is used it may be milled, or planed to size. If it is planed the surfaces are finished very smooth by using a finishing tool like that in Fig. 10, which if made and ground properly cuts very smoothly. It must, however, only remove a very small amount of stock, and it works best if the surface being machined is well covered with oil.

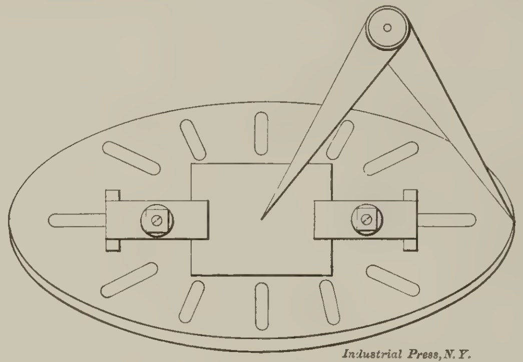
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Fig. 12.

If stock of the desired size is used and there is no grinder, the surfaces may be finished square and flat by draw-filing, after which the spring *B*, Fig. 9, is made from sheet steel. Either tool steel or spring sheet steel must be used so that it may be spring-tempered to furnish sufficient tension to keep the end of pointer in the prick-punch mark in work being trued. The spring may be shaped, as shown, or given any desired shape, according to individual taste. Then the prick-punch mark is made near the small end, as shown, and it is drilled onto the shank. Next it is hardened and given a spring temper, after which it may be polished and drawn to a full blue color, if desired. If the tool is of machinery steel the shank may be casehardened, after the name has been stamped upon it. If casehardened its appearance will be enhanced by doing the work in such manner as will produce colors.

The indicating wire may be made in three pieces. The short straight piece *C* is pointed to an angle of 60 degrees on each end, one end entering the prick-punch mark in the work to be tested, while the other enters the depression in the spring portion of shank. The connection *D* is drilled and threaded to receive the long wire, as shown, while on the opposite end it is drilled and threaded to take a knurled headed setscrew. At right angles to these holes another hole is drilled to receive the short wire *C*. The long wire is bent in shape of a half circle, and the extreme end is pointed, as in this condition a slight movement of the wire is more easily noticed. There are other styles of indicators

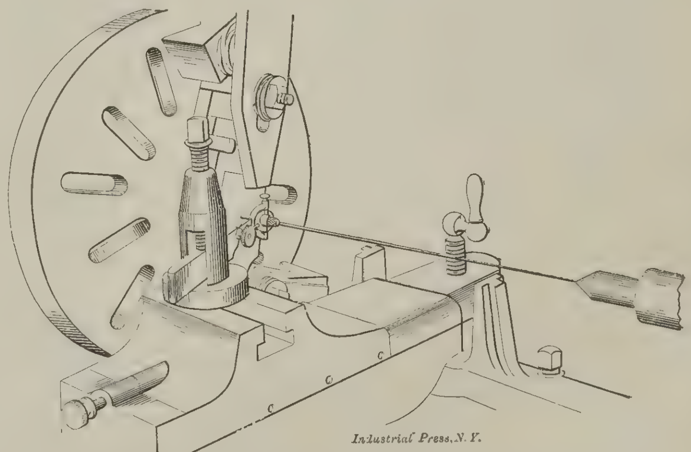
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Fig. 13.

which require more skill in their manufacture than the one described, but this will answer for the general run of work.

If an extremely long indicating wire is needed in order to detect slight errors of location, as in drill jig, model and gage work it is necessary to make the indicator portion of wood, as a steel wire would be affected by the tremor of the machine resulting from the slight vibration of the floor noticed in all machine shops. In such cases the *wire* may be made short, as shown in Fig. 11, a hole drilled in the end and a wood extension fitted, as shown.

The die blank should be securely fastened to the lathe faceplate by means of straps and bolts. It may be located so the center of the blank is approximately central with the faceplate by means of a large pair of dividers, Fig. 12. Screw faceplate on the lathe spindle, then adjust the blank until the center—prick-punch mark—is exactly central, by rapping, testing it for truth with the indicator. To make sure of the hole being true with the surface of the blank clamped against the faceplate, be sure that the faceplate runs true when it is screwed on the lathe spindle. There should be no dirt or chips in the thread or on the shoulder of either the faceplate or lathe spindle. Now screw the faceplate on spindle and test the face. Should it run out of true remove it from spindle and look again for dirt, and if none be found, screw it on spindle and *true* the face.

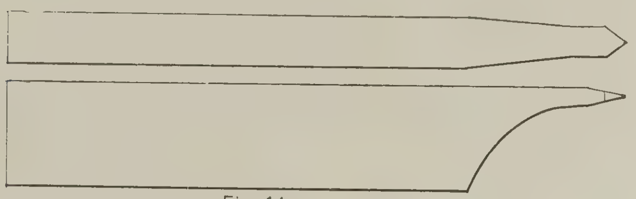

Fig. 14

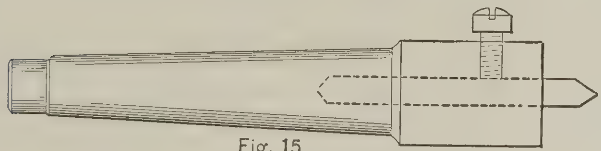

Fig. 15

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For clamping work to faceplate use straps and bolts whose weight is as nearly alike as possible. The work in question being small the straps would be near the center of faceplate, so a slight difference in weight would make no material difference; but these explanations of various methods are intended to cover, so far as possible, similar operations on other classes of work, to which the above would apply.

Should the work be large and have one heavy and one light side, opposite each other, or were it necessary to use more straps on one side than the other, then of course one side would be heavier than the other. In such cases add weight to the faceplate on the side corresponding to the light side of work, to make the two sides balance. This weight is known as a "counterbalance." Unless work of this class is counterbalanced it will be impossible to machine surfaces true, or turn the projections, or bore holes that will be round.

When work is strapped to the faceplate, screw the faceplate onto the spindle and true the work, testing with the indicator, as shown in Fig. 13. The work should be moved on the faceplate until the extreme point of long end of indicator wire remains fixed, when the work is revolved. Do not run the lathe spindle by power; throw the belt off the cone and revolve the work by hand. The belt is not equally flexible in all parts, and the portion where the belt is laced together, with other causes, would bring an unequal action on the spindle bearings and cause the indicator wire to move when it should not, thus deceiving the operator.

As stated, the *center* of the die should be prick-punched. Use the *prick-punch*, not the center punch for this purpose. The prick-punch should have its point ground at an angle of 60 degrees and should be ground in some machine where it can be held in a chuck or collet to insure the point being *perfectly round*. If the point is not round the mark it makes will not be round, and when the indicator point is inserted in it and the piece revolved, the point of wire may be affected by the untruth of the depression and move somewhat. This slight movement at this end would be greatly magnified at the indicator end and deceive the workman. This is especially true if the end of wire—point—which enters the prick-punch mark is not exactly round; so, to avoid any liability of error, both the prick-punch and the point of wire should be ground as above described.

When the work has been strongly fastened to the lathe faceplate and it runs true, we can proceed to drill and bore the hole to tapping size. Some toolmakers are very careless when drilling the first hole through work that is to be bored, claiming that if the drilled hole runs out of true somewhat it can be brought true with the boring tool. I think this a mistake; nothing should be done wrong that can be prevented by reasonable care, simply because it can be made right by after operations. Most tool room lathes are provided with centering tools, made purposely for finding the center of work to be drilled, or for making a depression to receive the point of the drill, thus insuring its running true when cutting. Sometimes these are made on the end of a piece of stock to be held in the toolpost, as shown in Fig. 14, while at other times a collet is made which fits the tail spindle of lathe, the end of collet projecting far enough beyond the end of spindle to allow of a setscrew to hold a drill inserted in end of collet, as shown in Fig. 15. This drill projects but a trifle beyond the end of collet, is therefore very rigid and cannot run; consequently it centers the work very true.

As a twist drill gives best results when its cutting edges are ground at an angle of 59 degrees with the sides, as shown in Fig. 16, care must be exercised in regard to the centering drill; if that is ground at the angle mentioned the point must be very thin, or a flat portion will be the result at bottom of the centering. The amount of flat will of course correspond with the width of point of drill. Now if the flat portion produced in the bottom of the centering is greater than the width of the point of drill to be used in drilling, then the drill will probably run out of true. Some toolmakers grind the centering drill at a greater angle than the drill used to drill the hole, while others grind it at the same angle and "wheel out" the flute at the end of the drill, thus making the point very thin—thinner in fact than the point of the drill to follow it. This is largely a matter of opinion; I think the latter method the safer unless the cutting end of the drill is steadied when it first starts cutting.

After drilling the hole, use a boring (inside turning) tool to bring it to the correct size for threading, unless a reamer is at hand which will produce a hole tap size. If many dies of a size are to be made it is advisable to have a reamer. In fact, where several dies of a size are to be made or where dies are made occasionally it is best to keep a set of tools especially for the purpose. The necessary tools would of course depend on the size and character of the die, but for most dies would consist of a drill, and if the die were sufficiently large a boring tool, a reamer, taper reamer (countersink) and taps.

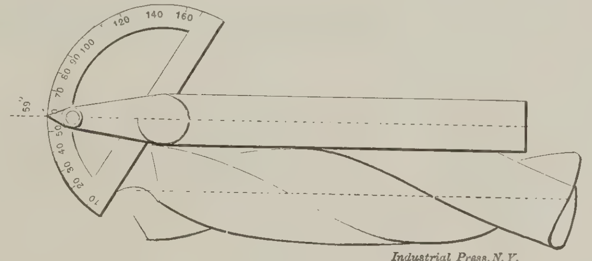

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Fig. 16.

It is perhaps well to state at this time that a screw thread die is *always* designated by the size of screw it is to cut, and not by the diameter of the piece containing the die. It is therefore readily apparent that a ½-inch die may be 1¼ inch outside measurement, or it may be 2 inches. But while it is customary to make dies of a size that will fit holders at hand, yet there are certain dimensions which govern in a measure the outside dimensions and the thickness. The outside diameter should not be made much less than 2½ times the diameter of the screw to be cut; that is a ½-inch die should be at least 1¼ inches outside diameter, and the thickness of the die, Fig. 17, may be 1¼ times the diameter of screw to be cut.

Should it be necessary in order to use holders at hand to make the die thicker than amount mentioned, it may be cut away, as shown at Fig. 18.

It is not expected that the reader will attempt to follow to the letter the instructions just given, as it would be necessary to make a holder for each different size of die. Quite a range of sizes may be made to the same dimensions to fit the same holder. The dimensions are given to furnish the reader an idea of the approximate sizes generally accepted, and apply more particularly to round dies, as square dies are made of a size that corresponds to the opening in the holder of the machine in which they are used.

When but one die of a size is to be made, and there is no tap of the proper size at hand, it is advisable, if the opening in die is sufficiently large, to cut the thread with an internal threading tool. Gage the size by a male gage, if one is to be had; if not, use a screw that is correct as to diameter and pitch.

Where there is but *one* tap, it is considered good practice to cut the thread nearly to size with an internal threading tool, then to finish to size with the tap. Do not, however, cut the thread too near finish size with the threading tool, as any variation in pitch of the thread of leadscrew and of the tap, occasioned by the tap changing in hardening, would cause the thread to be imperfect at the back end of die. For the same reason—alteration of lead when hardened—it is advisable to leave a sufficient difference in sizes of taps used (if there are several) so that the larger tap will cut a sufficient amount to make a perfect thread.

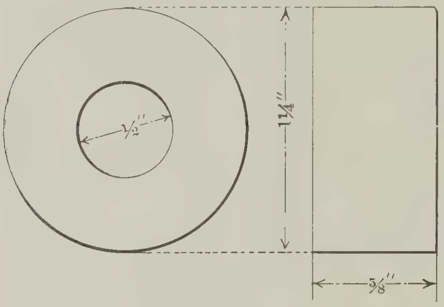
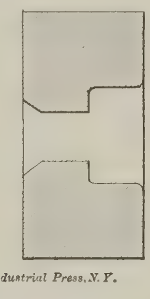


Fig. 17.



Industrial Press, N. Y.

Fig. 18.

In the making of taps for threading dies and similar work, the mistake is sometimes made of cutting all the threads of the various taps to the same diameter, and then the tops of the threads of the first tap are cut away, as in No. 1, Fig. 19, the tops of the threads of No. 2 not cut away as much, while No. 3 is left full size. Now it is apparent that any change in lead of the various taps *must* manifest itself in the tapped hole, which, in the case of a die, or similar tool, would be fatal. It may appear to some that more space has been given to the consideration of the liability of change of lead than is necessary, but years of experience have convinced the writer that it is all important, and at the same time not understood by every one.

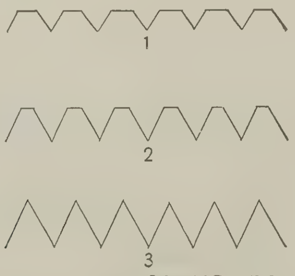


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Fig. 19.

In order that the die may cut it is necessary to chamfer the threaded hole back for a distance of three or four threads, according to the pitch of the thread—a thread of fine pitch not requiring as much as one of a coarser pitch. Do not use a taper reamer that will make the chamfer at the surface of die much greater than the size of die when it has cut the desired depth.

In shops where they make the clearance holes one-half the size of the die, and where they have centers of the clearance holes at the intersection of a circle whose diameter is equal to the diameter of the screw to be cut, and the four equidistant spaced lines crossing the center, as shown in Fig. 7, it is necessary in order to lay out a circle of the size mentioned after the die has been drilled and threaded, and also be able to drill the clearance holes without the use of a drill jig, to turn a screw into the threaded hole and face it off flush with the die. The writer's experience, however, is not of a nature that allows him to look with favor on clearance holes of the size mentioned; the holes being small quickly fill with chips which tear the threads of the screw being cut, thus producing an unsatisfactory screw. Make clearance holes large enough to allow the chips to enter the holes easily, and also to allow chips to be removed by the stream of oil which runs on the wire being threaded, to cool the die and lubricate the cutting edges.

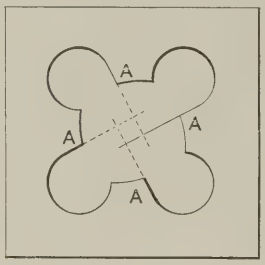
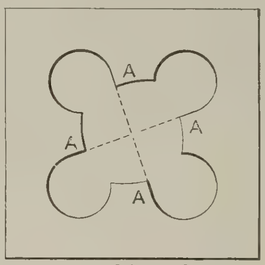


Fig. 20.



Industrial Press, N. Y.

Fig. 21.

After laying off the clearance holes, and prick-punching for center, a small hole is drilled to accommodate a counterbore whose body is the desired size of the clearance holes. Next, the holes are counterbored to size, the faces of the cutting edges filed smooth, the back of the land filed to make the land of the proper width, and the chamfered portion also filed for clearance.

When filing the *face* of the cutting edge it may be necessary to somewhat alter the location of the face, it being considered good practice to make them radial for such work as ordinarily comes to hand in a machine shop. When they are to be used wholly for threading cast brass, and the various other alloys of copper, some toolmakers give the faces a *negative rake*—that is, cut back of center—as shown in Fig. 20; while others claim best results on all classes of work if the faces are made radial—on line with the centers, Fig. 21. The back of the land is filed to remove any burrs thrown between the threads by the counterbore when making the clearance holes, and to make it proper width, as a land that is too wide has too great an amount of bearing on the screw being cut, while a land that is too narrow will chatter and produce an imperfect thread. It is customary to give dies having four cutting edges a thickness of land at portion marked *A*, Fig. 21, a width equal to from 1-20 to 1-16 the circumference of the screw to be cut. Use the utmost care when filing the chamfered cutting edges for clearance, as it is right here that many make the mistake of thinking the only thing necessary is to file off a little more stock at the heel than at the cutting edge. In reality no stock should be removed from the cutting edge. Commence filing at the heel of land and gradually go toward the cutting edge, just bringing this to an edge and being sure nothing is taken from the edge. If a greater amount is removed from one cutting edge than from another the shorter land will not cut, and its share of work must be done by the next cutting edge which has, in addition to this, its own work to do; and no one cutting edge can do the work of two and produce a smooth thread.

In our next article we will conclude the subject of dies and take up round dies, spring dies and dies with inserted blades.

* * *

The "slip" of pumping engines due to leakage past the pistons and valves, is commonly as much as five per cent. where the inside packed plunger is used, and frequently is much more. A test of a small pumping engine forming part of the Brooklyn water supply system, showed the slip to be twenty-two per cent. of the plunger displacement. That is, for every 100 strokes of the plunger, 22 strokes were wasted by the leakage. With the outside packed plunger the leakage is practically reduced to that due to defective valves.

SPINDLE CONSTRUCTION.—1.

MODERN METHODS, DISCUSSED IN DETAIL.

HOWARD P. FAIRFIELD.

The spindles used in boring mills, drill presses, milling machines and lathes are usually fitted with a threaded nose, and a tapered hole to hold a collet, an arbor, or a pointed center. Milling machine and lathe spindles are also made with a hole throughout their entire length in addition to the other features. This hole is a convenience in many ways, as it is possible to pass stock through the hole to be operated upon. In the flat turret lathe and in the different makes of screw machines this is the principal method of feeding stock to the several tools held in the turret of the machine.

The spindles of the above-mentioned machines are either made from a good bar of machinery or 20-point carbon steel, or they are made from crucible steel forgings of about 50-point carbon, and are commonly spoken of as hammered crucible steel spindles. High carbon or tool steel is used at times for spindle work, but this can be classed as special spindle work and its use is rare. The requirements of spindle construction are that the spindle be perfectly straight, that the journals be round, straight, and true running, that the nose be threaded to run true with the journals, and that the tapered center hole also run perfectly true with the journals. The spindles in any of the first-class machines are constructed to fulfill all these requirements to a remarkable degree. Several makers, for example, test the truth of the tapered hole with a test bar of at least one foot in length and allow a vibration of less than 1-1000 of an inch from truth at the outer end of this test bar, a severe test when one considers that these are not special machines but are their regular commercial products.

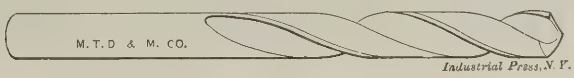


Fig. 1.

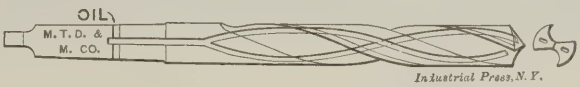


Fig. 2.

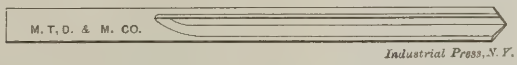


Fig. 3.

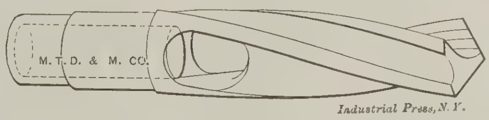


Fig. 4.

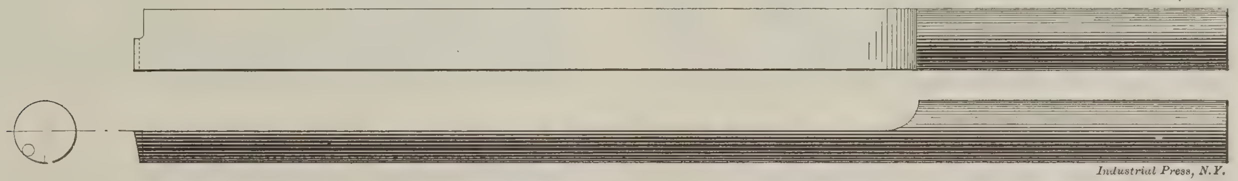


Fig. 5.

The producing of holes throughout the length of spindles and shafts has led to the devising of machines and appliances for deep drilling that are peculiar to such work. To commercially drill spindles at a profit requires that the maximum feed be maintained. It is a matter largely of furnishing a free cutting tool, amply lubricated and cooled, and keeping the hole free from the cuttings or chips. No method that does not fulfill the above conditions can be said to be a complete success. Where, however, but few spindles are to be drilled, and when the number does not warrant the purchase or construction of special spindle drilling machinery, the engine lathe or a drill press can be used to do the work. Owing, however, to the difficulty of keeping the hole freed from chips when the work is held vertical, the lathe is the more used tool or machine for this drilling job. The drills used in deep drilling of this sort are the ordinary twist drill, Fig. 1, the oil tube twist drill, Fig. 2, the straight flute or "Farmer" drill, Fig. 3, the half round drill or hog nose drill, Fig. 5, and the special hollow drill, shown in Fig. 4. This last drill is used in a special drilling machine as a rule and not in ordinary lathe drilling.

Where only a few spindles or shafts are to be drilled the common twist drill, shown in Fig. 1, or the straight fluted drill, shown in Fig. 3, are used. As they are ordinarily made of much shorter lengths than the hole to be drilled is likely to be, some means must be used to lengthen them sufficiently to allow of the reach desired. This can be accomplished by first turning the shank end of the drill below size. The stem or shaft to lengthen the drill can be a piece of cold rolled steel of the same diameter as the drill. A hole is made in one end of this stem of a size that will closely fit the reduced shank of the drill. The turned down shank of the drill is then "tinned" with solder and some of the soldering acid is dropped into the hole in the stem. To put the two parts together grasp the drill next to the reduced end with a pair of gas pliers, and by holding the tinned end of the drill and the drilled end of the stem in a Bunsen flame, they can, when heated sufficiently to make the solder run, be forced together. When cool they will be capable of withstanding lots of work. This process is termed in the shop "sweating in" a drill or "sweating" two surfaces together. Where the hole to be drilled is of such a depth relative to its diameter as to make the length of shaft or stem so great that it will be too slender to use when the hole is first started, several stems of varying lengths may be provided. The process of sweating on these stems is so simple that one stem when used to its depth can be unsoldered and another and longer one sweated into its place. The holding of the drill in a hand vise or pipe pliers when soldering insures keeping the flutes cool beyond the part so held and the hardness of the cutting parts is not disturbed. In deep drilling with this tool it is necessary to withdraw the drill as often as the flutes are filled with chips, to allow of their removal and also to lubricate the cutting edges. As this is time consuming, when many spindles are to be drilled in the lathe, the oil tube drills shown in Fig. 2 are better for the purpose. The oil tubes are joined at the rear end or shank of the drill and are covered by some form of hollow bushing. This bushing is tapped upon its circumference to take a short piece of gas pipe. A hose connection between this short piece of gas pipe and the oil pump allows the oil to be forced through the oil tubes to the cutting lips. To allow the chips and oil to force out, two straight grooves are milled on opposite sides of the stem or shaft and connecting with the helical or twisted flutes. To break up the chips and insure their being forced out by the oil, notches or steps are ground in the cutting lips of the drill. These notches must always be of a greater depth than the distance the drill advances per revolution. If the drill is sharpened upon a drill grinding machine each lip will cut evenly, and chips should come away evenly from each cutting edge. Drill grinders, however, are designed to leave the end of the drill of such a form as will allow it to just clear the bottom of the hole being drilled. As the oil tubes end in this surface the oil is prevented by this small clearance from flowing to the full capacity of the tubes, and it is necessary to grind the back edge of the flute off squarely up to the end of the oil tube. This weakens the cutting edge somewhat, but does not do so to an extent worth considering and does allow of a free flow of oil. The half round or hog nose drill shown in Fig. 5 can be used in either the engine lathe for drilling or in a special drilling machine designed for drilling spindles. It is usually used, in fact, in the special drilling machines of one company the writer knows of, for all holes under one and one-quarter inches. In its smaller sizes the hog nose drill is usually made of tool steel and the cutting end cleared and hardened the same as a lathe tool. In the larger sizes the drill is made of machinery steel and a tool steel cutting die is fitted to the leading end. The edge of this drill is also notched to break up the chips as in the drills spoken of above. This drill, when correctly made, ground and started will, if well lubricated, leave as round, true, and finished a hole as any drill that is made.

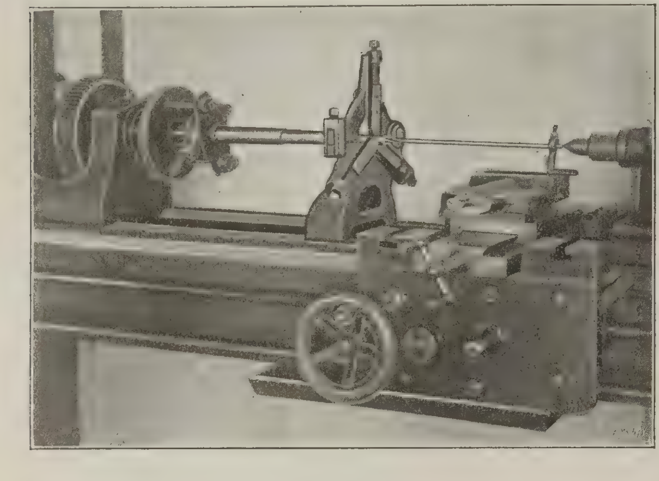


Fig. 6. Lathe Set up for Spindle Drilling.

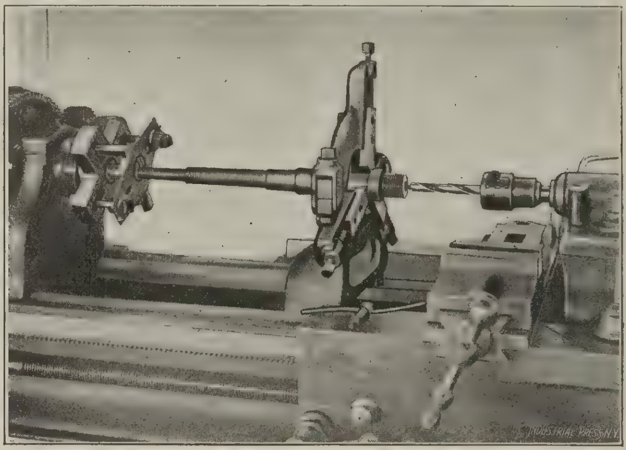


Fig. 7. Drilling for the Taper Hole.

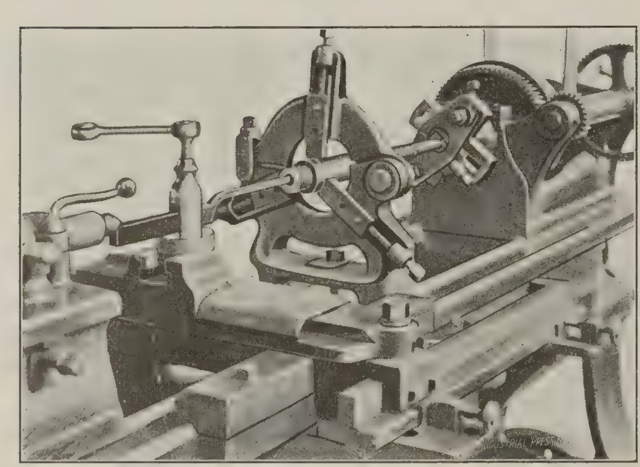


Fig. 8. Boring the Taper Hole.

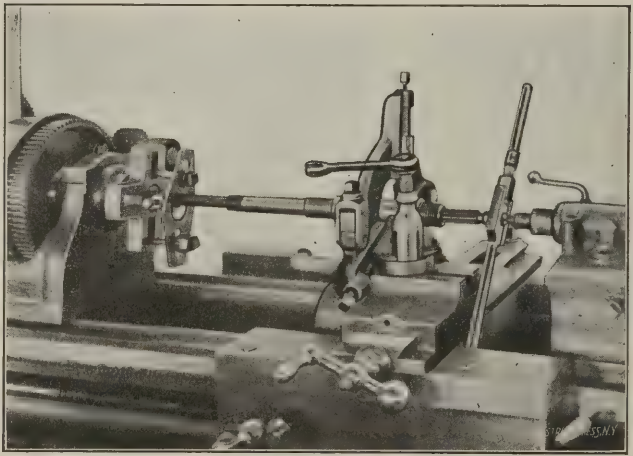


Fig. 9. Reaming the Taper Hole.

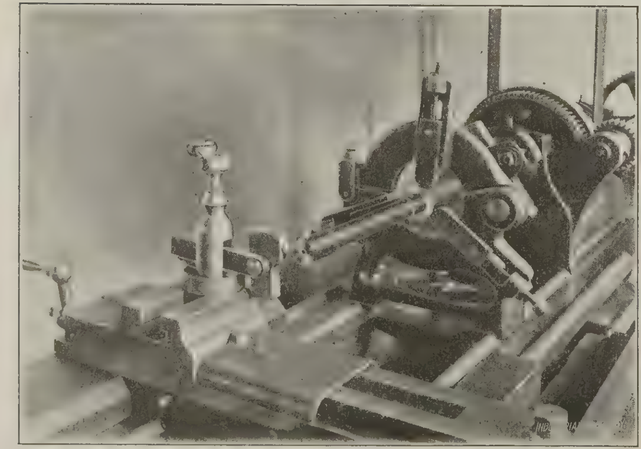


Fig. 10. Use of Test Bar and Indicator.

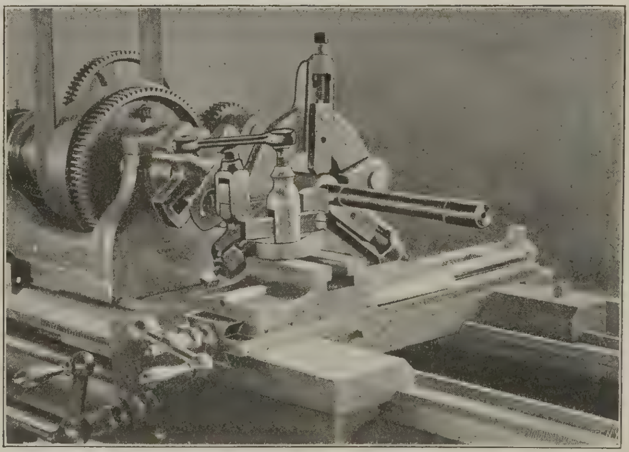


Fig. 11. Testing at the Inner End of Bar.

In Fig. 7 is shown an engine lathe set up for drilling the lengthwise hole in a spindle. In this case as the spindle is rather slender and liable to spring while it is being worked upon, the tapered center hole is made the last operation in the construction, the bearings being ground just previous. This order should always be followed for slender spindles to insure the truth of the tapered hole with relation to the bearings. The spindle is first roughed to a finishing allowance and short bearings are turned upon the ends to an exact degree of roundness for center rest support. The larger end or nose of the spindle is placed upon the live center, which is supposed to be trued up nicely, and is held in place on the center by a "hold back," as shown. The smaller or what will finally be the back end is run in a center rest and is drilled into a short distance with a drill somewhat smaller in diameter than the drill to be finally used. An inside boring tool held in the lathe toolpost is then used to enlarge the small hole to a size that will allow the drill it is intended to use to just slip in without shaking. The drill is in this manner started in its cut perfectly concentric with the center line of the work. Drills sweated into shanks or stems of varying lengths are used to drill the hole to a depth sufficient to meet the tapered center hole when it is machined. This leaves the center hole in the faceplate end of the spindle untouched until all operations are finished. Before removing the spindle from the center rest the edges of the hole are chamfered to an angle of 60 degrees and to a sufficiently broad surface to form a bearing for the centers when finishing and grinding. If the spindle is stiff enough to warrant finishing the tapered centered hole before grinding and finishing the spindle, it must be held with the small end trued up in a chuck instead of on the live center. This brings the work in the reverse of the position shown. The nose is held in the center rest, a true running bearing having been turned where it is to bear in the center rest. As said before, the spindle is roughed to a finishing size before drilling. The hole is then started true and is drilled as before. If the hole is large enough, however, and the spindle stiff enough, the hole may be drilled by using some of the oil tube drills mentioned above.

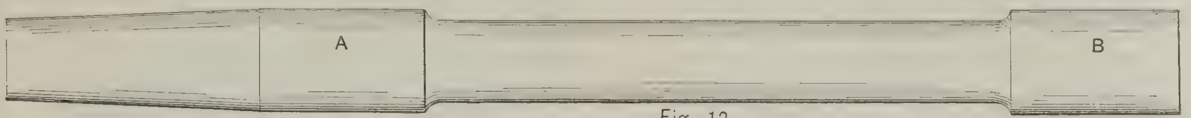


Fig. 12

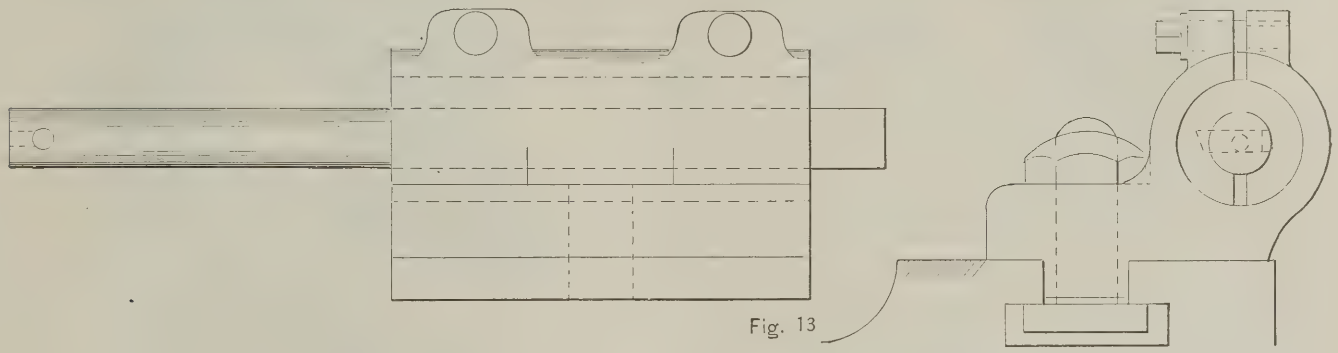


Fig. 13

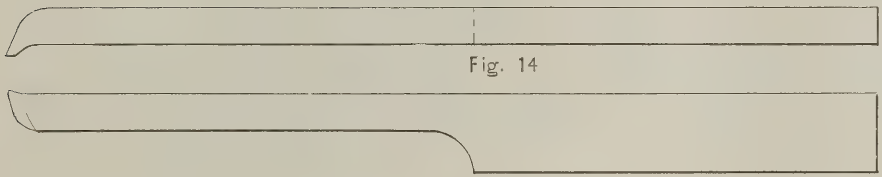


Fig. 14

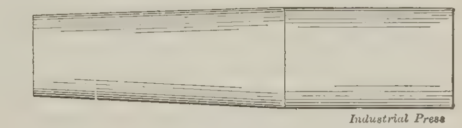


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Fig. 15

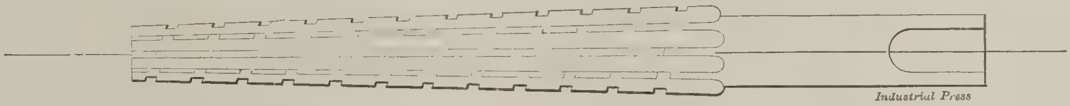

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Fig. 16.

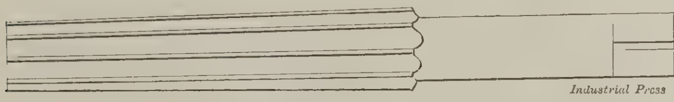

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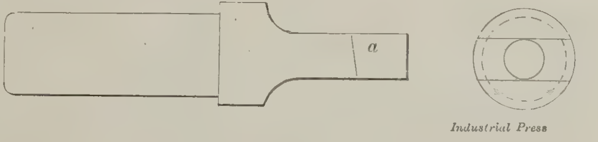
Fig. 17.



Industrial Press

Fig. 18.

Fig. 7 shows the spindle mounted ready to have the tapered center hole machined. The drill used to rough the hole is slightly smaller in diameter than the finished hole is to be in smallest part. After the hole is drilled a roughing reamer like the one shown in Fig. 16 is used to fully rough out the hole and leaves the hole of an approximate size and taper. To true the hole to perfect concentricity it is bored out with an inside boring tool held in the lathe toolpost, as in Fig. 8. A lathe having either a compound toolpost or a taper attachment must be used for this job. The first setting of the taper will scarcely be more than an approximation, and alterations must be made after each cut until the tapered hole is like the standard used. A plug, as shown in Fig. 15, may be provided as a standard, or the finishing reamer, Fig. 17, may be used to try the taper with. Fig. 8 is a back view of the lathe and shows the taper attachment coupled up to bore the tapered center hole. The hole is bored in this manner to the right diameter and finished smooth by scraping a few thousandths out with the finishing reamer held as shown in Fig. 9. If all the operations have been carefully carried out the hole will be true when tested with the test bar shown in Fig. 12. This test bar is of tool steel hardened and ground upon the tapered surface and at the diameters *A* and *B*. Its length outside the tapered part may vary from seven inches to fifteen inches, and it must be known to be a perfect job and a standard. To use this bar the tapered hole is carefully wiped out, that no chips or oil be present. The bar is then inserted and pressed home with a slightly twisting pressure. A Bath indicator can then be held in the toolpost of the lathe with its feeling point touching the test bar as in Fig. 10. The work is rotated at a medium speed and the bar is tried at both *A* and *B*. If the error shown by the indicator is greater than the limit set for the job a light cut with the boring tool and another light reaming may be necessary. If, however, the hole is only slightly out of truth the high side of the hole can be marked and a light scraping with the finishing reamer upon that side will true it up. Not much stock must be removed in this way as the result of scraping upon one diameter is to make the hole oblong instead of round. When the hole has been bored and reamed very carefully the bar will not usually run out on the first trial more than .001 inch in 10 inches and a touch of scraping will put this error right. The inside boring tool shown held in the toolpost in Fig. 8 is the common forged tool and its usual form is shown in Fig. 14. Where shallow holes are to be turned out this is a good tool and is cheaply made. The tool and holder shown in Fig. 13 is, however, a better form when much work is to be done. The bar that holds the tool can be revolved to bring the tool point into any desired relation to the hole. By the use of suitable bushings, bars of any diameter may be used and the length of bar can be easily suited to the length of hole it may be used upon. This holder takes several shapes or forms in different shops and is well worth its cost. When large holes are to be started in the end of the spindle a small drill may be used to drill a shallow hole. The shallow hole can then be turned concentric with an inside boring tool, as stated above, and finally enlarged to the diameter of the drill to be used, by counterboring with the tool shown in Fig. 18.

The "tit" or leader (*a*) is a nice fit in the smaller concentric hole and leads the cutting edges straight with the center line. A depth sufficient to admit the sizing drill beyond its cutting edges is all that needs to be made with the counterbore.

Taper reamers have a tendency to draw into the work when in use. To counteract the drawing-in action it is common practice to cut a left-hand helix upon the reamer. Finishing reamers are, however, seldom treated in this manner, as their use is to just scrape the hole to a perfect surface. A left-hand helix is undoubtedly a help when using the roughing reamer. There are several errors that one is apt to make in finishing a tapered hole in a spindle. 1. If the spindle is slender care must be taken that the hold-back or clamp does not spring the work by being tightened up too hard. Anything more than enough to hold the work upon the center is too much. 2. In turning the hole out with the boring tool set the cutting point upon the center line of the lathe to get straight sides to the tapered hole. 3. Be sure that the center line of the work and the live and dead centers are coincident with the center line of the lathe. Fig. 19 shows the interior of the Bath indicator and the several feeling points used. This is a very sensitive tool, a movement of 1-2000 inch of the feeling point moves the indicator finger a distance of 1-12 inch.

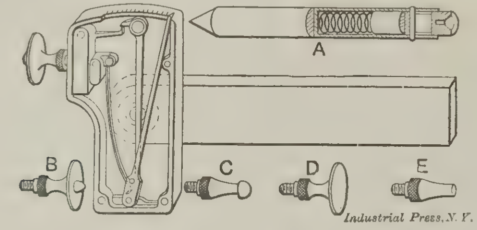


Fig. 19.

* * *

REAMER CLEARANCES.

FRED HOLZ.*

After constant experimenting for a period of more than one year, we have finally succeeded in establishing tables for four styles of reamers for obtaining the best possible clearances, the object being to grind clearances on reamers which would ream the greatest number of smooth holes with a minimum amount of wear. The four styles of reamers are as follows: Hand reamers for steel; hand reamers for cast iron and bronze; chucking reamers for cast iron and bronze; chucking reamers for steel. We use adjustable blade reamers almost exclusively, all of which are ground in the tool room. No one outside of the tool room is allowed to adjust the reamers in any way.

When we began this series of experiments, a report was kept of every reamer as to what kind of clearance it had ground, and when it was returned to the tool room, it was accompanied by a report stating the number of holes it had reamed. The newly ground reamers were made to ream holes from ¼ of a thousandth to ½ of a thousandth above size, and were allowed to wear down to standard size when they had finished their performance. Various kinds of clearances were tried with varied results, until we reached a limit of reaming 1,070 holes with the same hand reamer before it showed any sign of needing regrinding or readjusting. These holes were ⅞ inch in diameter, 1 inch long, in parts made from shafting material known as "hub stock." These holes were from .001 to .002 inch under size before hand-reaming, and were perfectly smooth when finished.

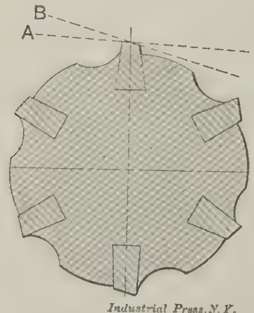


Fig. 1. Showing Reamer Clearances.

When reaming cast iron or bronze, only two or three hundred pieces could be reamed, since the wear of the reamer on these materials is much greater than in steel, although could the error limits of the holes be greater, of course a larger number could be reamed before the reamer would need readjustment. In our practice we aim to have all the holes as near standard as possible, and the variation in the fits, such as for running and driving, is made in the shafts.

Fig. 1 shows a hand reamer. It will be noticed that there are two clearances ground on same, *A* and *B*. A small land of .025 inch wide is left on all hand reamers for cast iron and bronze; a land of only .005 inch is left on hand reamers for steel. Chucking reamers for cast iron or bronze have 23 degree beveled ends and are provided with two clearances along the blades (See Table 3). The beveled ends have only one clearance equaling the second clearance given in Table No. 3. Chucking reamers for reaming steel have the knives circular ground to exact size of hole to be reamed. The 45-

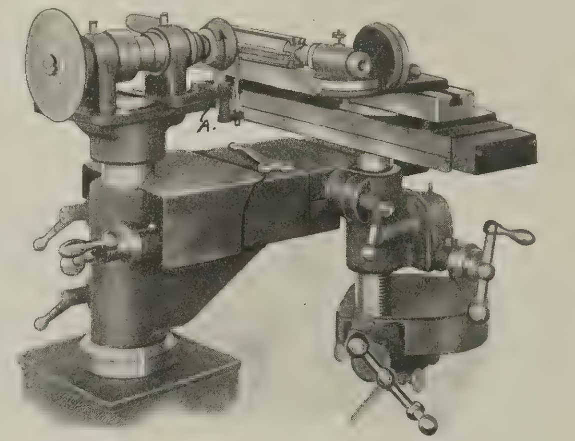


Fig. 2. Showing Stationary Tooth Rest; Grinding Clearances.

	*TABLE NO. 1.		*TABLE NO. 2.		*TABLE NO. 3.		†TABLE NO. 4.
	Hand Reamer for Steel. Cutting Clearance. Land .006" wide.		Hand Reamer for Cast Iron and Bronze. Cutting Clearance. Land .025" wide.		Chucking Reamer for Cast Iron and Bronze. Cutting Clearance. Land .025" wide.		Chucking Reamers for Steel, Circular Ground.
Size of Reamer.	For Cutting Clearance.	For Second Clearance.	For Cutting Clearance.	For Second Clearance.	For Cutting Clearance.	For Second Clearance.	For Cutting Clearance on Angle Angle on End of Blade 45 Degrees.
½	.012	.052	.032	.072	.040	.080	.080
9/16	.012	.057	.032	.072	.040	.080	.080
⅝	.012	.062	.032	.072	.040	.090	.090
11/16	.012	.067	.035	.095	.040	.100	.100
¾	.012	.072	.035	.095	.040	.100	.100
13/16	.012	.077	.037	.095	.045	.125	.125
⅞	.012	.082	.040	.120	.045	.125	.125
15/16	.012	.087	.040	.120	.045	.125	.125
1	.012	.092	.040	.120	.045	.125	.125
1 1-16	.012	.097	.040	.120	.045	.125	.125
1 ⅛	.012	.102	.040	.120	.045	.125	.125
1 3/16	.012	.106	.042	.122	.045	.125	.125
1 ¼	.012	.112	.045	.145	.050	.160	.160
1 5/16	.012	.118	.045	.145	.050	.160	.160
1 ⅜	.012	.122	.045	.145	.050	.160	.175
1 7/16	.012	.127	.045	145	.055	.175	.175
1 ½	.012	.132	.048	.168	.055	.175	.175
1 9/16	.012	.137	.050	.170	.055	.175	.175
1 ⅝	.012	.142	.050	.170	.060	.200	.200
1 11/16	.012	.147	.050	.170	.060	.200	.200
1 ¾	.012	.152	.052	.192	.060	.200	.200
1 13/16	.012	.157	.052	.192	.060	.200	.200
1 ⅞	.012	.162	.056	.196	.060	.200	.200
1 15/16	.012	.167	.056	.196	.064	.200	.200
2	.012	.172	.056	.216	.064	.224	.225
2 1/16	.012	.172	.056	.216	.064	.224	.225
2 ⅛	.012	.172	.059	.219	.064	.224	.225
2 3/16	.012	.172	.059	.219	.064	.224	.225
2 ¼	.012	.172	.063	.223	.064	.224	.225
2 5/16	.012	.172	.063	.223	.064	.224	.225
2 ⅜	.012	.172	.063	.223	.068	.228	.230
2 7/16	.012	.172	.063	.223	.068	.228	.230
2 ½	.012	.172	.065	.225	.072	.232	.230
2 9/16	.012	.172	.065	.225	.072	.232	.230
2 5/8	.012	.172	.065	.225	.075	.235	.235
2 11/16	.012	.172	.065	.225	.075	.235	.235
2 ¾	.012	.172	.065	.225	.077	.237	.240
2 13/16	.012	.172	.065	.225	.077	.237	.240
2 ⅞	.012	.172	.070	.230	.080	.240	.240
2 15/16	.012	.172	.070	.230	.080	.240	.240
3	.012	.172	.072	.232	.080	.240	.240

† Mount tooth rest on table of machine.
* Mount tooth rest on emery wheel head.

---

* President Cincinnati Milling Machine Co.

degree beveled ends only have clearances. (See Table No. 4). On all reamers of this style the knives are ground from .015 to .020 inch below size half of their length, toward the shank end. In grinding the clearances for the various kinds of reamers as given in Tables No. 1, 2, and 3, the tooth rest is held stationary on the emery wheel head of the grinder, Fig. 2, while for the clearance for the 45-degree beveled ends on the chucking reamers for steel, the tooth rest is supported from the grinder table and travels with the work. (See Fig. 3.) We oil-stone our chucking reamers and hand reamers for cast iron and bronze, but not the hand reamers for steel. A micrometer is used for measuring over the blades for size. We use India oil stone, medium grade, and use gasoline instead of oil. The front end of all hand reamers is tapered about .005 inch in 1¼ inch. The back end of the blade is also slightly tapered, so as not to injure the hole in backing out the reamer.

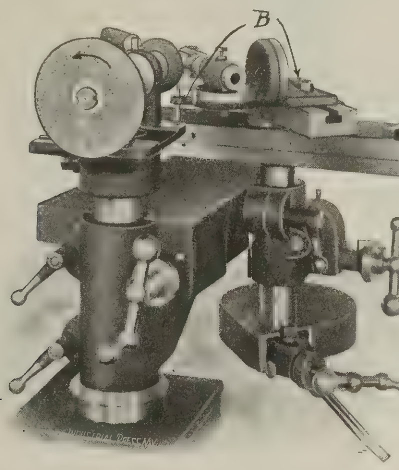


Fig. 3. Tooth Rest Attached to Grinder Table; Grinding Bevel on Chucking Reamers.

There seems to be a difference of opinion as to which direction an emery wheel should run in, whether it should run to or from the cutting edge of the reamer. The danger of carrying the heat to the edge is much greater when the wheel runs toward the edge, and thus the grinding must proceed more slowly and carefully. We grind all of our cutters and reamers whenever possible with the emery wheel running in a direction away from the edge. It requires very little practice on the part of the operator to hold the work to the tooth rest, and the result is more satisfactory, since it leaves a cleaner cutting edge, while the danger of overheating is reduced. In order to carry out this work precisely, it was necessary to provide the grinder with a micrometer dial on the vertical adjustment, as shown in Fig. 3.

The reamers as above described are ground on a Cincinnati Milling Machine Co.'s universal cutter and tool grinder.

* * *

The first wire-wound guns built for approval by the United States Government were faulty because of lack of longitudinal strength. They were built by winding steel wire over a set of steel staves which formed the core. The staves formed the sole basis of longitudinal strength and were inadequate; the muzzle of a wire-wound gun would droop after being fired a few times, and there was the ever-present danger of longitudinal rupture. The new design of this type is being built on somewhat different lines. The core consists of a thin tube which is fluted on its exterior similar to a reamer. Over this tube are wrapped eighteen steel sheets, for the 6-inch gun, in scroll shape, the inner end of each sheet being fitted into the groove or flute referred to. Each sheet makes about one-half turn at the powder chamber, but, as their width narrows toward the muzzle, less and less of the circle is included as the muzzle is approached. The principle of this construction utilizes the friction between the adjacent steel sheets to resist tangential rupture to the fullest extent since the coefficient of friction multiplied by the enormous pressure exerted by the superimposed windings, is greater than the tensile strength of the sheets. The steel plates, while not having so high a tensile strength as wire, are superior to a homogeneous steel tube, and, of course, strengthen the gun fully as much longitudinally.

PRATT INSTITUTE COURSES.

The annual report of Mr. Arthur L. Williston, director of the Department of Science and Technology, Pratt Institute, Brooklyn, N. Y., has been received. Pratt Institute is doing good work in all its departments but what is of especial interest to MACHINERY readers is the fact that it has courses in steam and machine design, shop work, applied electricity, etc., that are planned for the training of men to fill positions of the foreman type. This is touched upon in this year's report, from which we quote below:

"These courses occupy a rather unique position in the field of technical education. They are not to educate engineers, investigators or teachers of applied science, as are the four year courses in the colleges and universities, and it is not expected that they will enable their graduates to solve the more important problems in modern engineering; neither are they, on the other hand, trade courses, intended only for those who wish to become mechanics—they occupy a middle ground between these two. The trained workers in the electrical and mechanical fields are, in a general way, divided into three different classes; the first comprising the comparatively few men who originate and direct operations requiring the services of many. In this class we find the engineering experts, designing and consulting engineers, and many others who bear the prime responsibility for the successful operation of industrial and engineering enterprises. The third and last class is composed of the skilled laborers, and trained mechanics. Between the two there is a constantly widening field, the workers in which constitute the second class and occupy positions secondary and subordinate to the members of the first class, but nevertheless of great importance. They are the assistants to the engineers, the supervisors of skilled labor, or the specialists performing operations requiring a degree of knowledge and training in excess of that possessed by those in the third class. The commercial demand for technically trained workers of this second or intermediate grade is keen, and it is to afford a means for them to obtain the training that they need that the two year technical courses in the Institute are primarily intended. These are so planned as to give young men who have some natural mechanical ability a grasp of the practical details of mechanical and electrical machinery and apparatus; and a knowledge of the principles of its operation sufficient to enable them to inspect or supervise intelligently the construction or erection of it, or to design it in detail under the direction of the engineers who are responsible for it.

In electrical engineering work there is now an especially large class of positions needing men of just such attainments to fill them. A great variety of positions such as those included under the terms inspectors, department foremen, assistant superintendents, foremen of erection and maintenance, chief engineers in power plants, draftsmen, detail designers, and engineers' assistants of all sorts, all belong to this class."

Work of the character outlined in the above extract is to be highly commended. The complicated machinery and highly developed methods of present industrial work require well-trained men for foremen's positions. In many cases they must be men well grounded in general principles and capable of sound reasoning. It is commonly said that these positions are the most difficult to fill with the right kind of men, and a school endeavoring to supply courses of study for them should receive the commendation of all who have to employ men of this class. It is needless to say that having secured an education of this kind there is nothing to prevent a man's rising higher, if he has it in him to do it. Such an education ought to, and undoubtedly would, teach a student how to study, where to look for further information if he wanted it, and in general how calculations are to be made. We have no doubt that many students who have this foundation will, through further study carried on without the assistance of instructors, be enabled to obtain a very broad education.

* * *

The first electric railway in Peru was opened to traffic February 17, this year. This road is eight miles long and connects the capital, Lima, with a seaside resort. The cars and power plant are of American manufacture. Another road will soon be completed between Lima and Callao, which is the seaport. This line will be ten miles long and double track.

KOEHLER'S PROFILE LATHE.

ROBERT GRIMSHAW.

Ordinary lathes use for profile work either forming tools, or plain tools and profile guides. In some few cases it is necessary to employ more complicated appliances; this is for instance the case in turning crowned pulleys or hand-wheels; sometimes in working these hand work is needed.

Forming tools are used for small objects; for larger pieces there would be too much tool changing before the article gets its final dimensions and shape; so here profile guides are preferably used. The simplest such guide is a plain curved piece; and this can be used advantageously where there are no sudden steps; for instance on conical shells for ordnance.

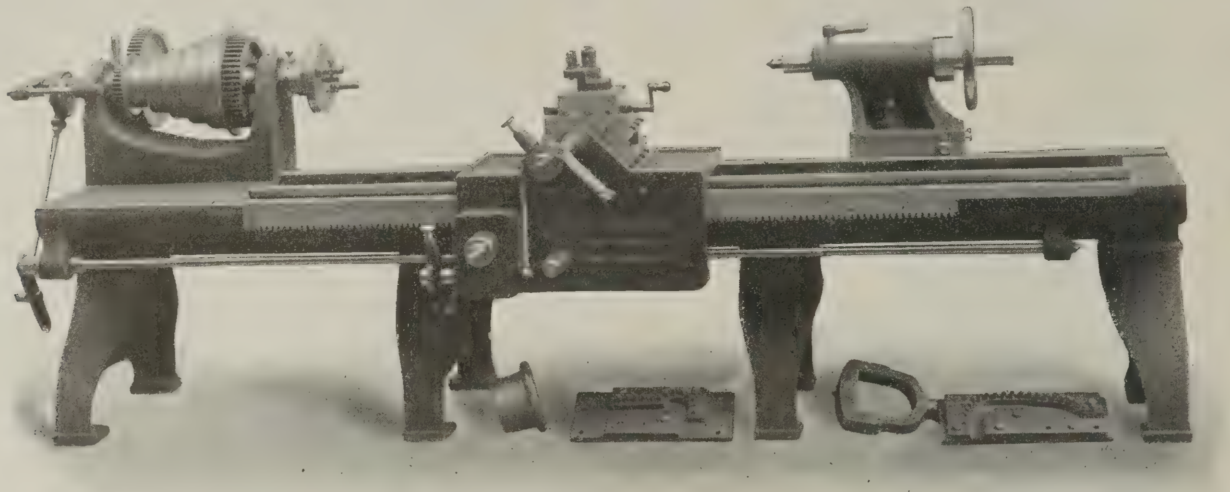


Fig. 1. Special German Lathe for Turning Irregular Forms.

For undercutting, or where there are sudden steps in the contour of the piece, there are sometimes employed profile guides having a lengthwise or a rotary motion. This is the case with working car-wheel flanges; but for this class of work the guide is limited to about 20 inches in length. Connecting and parallel rods, crossheads, piston-heads, cylinder-covers, etc., are often turned by hand.

The lathe shown in Fig. 1 is intended for working all sorts of profiles. The profile guides or cams correspond to the shape of the piece of work. The tool gets a regular motion along the edge of the guide. The feed is proportioned to the length of the curve and not to that of the ways. The tool and the copying point have similar paths, rendering impossible an error in copying. The guides can lie by unused while the lathe is used for straight work.

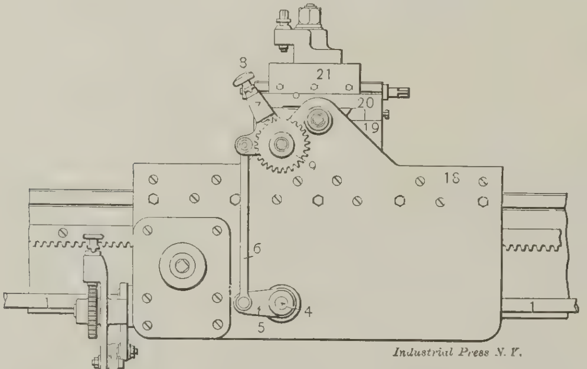


Fig. 2. Connections of Feed Device at Front of Carriage.

The head and tailstocks are of the usual design. The carriage runs on ways that project somewhat in front, and gets its motion from the main spindle by an eccentric and ratchet gear. Figs. 2 to 4 show the carriage with part of the bed; Fig. 3 is a vertical section of the carriage. Fig. 6 shows that part of the ways which is covered by the carriage in Fig. 5; also part of a changeable profile piece. The small gear wheel in Fig. 6 belongs to the carriage and gives it a motion corresponding to that of the profile piece.

By means of an eccentric on the spindle (see Fig. 2) the slotted shaft 1, Figs. 2 and 4, is given a vibrating motion, of variable amount, which is transmitted by the gears 2 and 3, Figs. 3 and 4, to the bolt 4, the lever 5 and the link 6 to the angle-arm 7. This latter bears a spring pin, 8, (Figs. 2 and 3), which can engage in the teeth of the gear 9 and effect the feed by means of the vibration of the lever 7.

If the spring pin 8 is raised a trifle and turned through 90 degrees, the wheel 9 is thrown out of action; if further turned through 90 degrees, wheel 9 is thrown in, but reversed.

The gear 9 is always in mesh with the shaft 10 (Figs. 3 and 5) and each time that it is thrown in causes a slight movement of the worm 11. (Figs. 3 and 5.)

The shaft 10 is adjustable in the worm 11, but has two spring keys, which run in corresponding grooves in the worm 11. As the worm is always in gear with the worm wheel 12 (Figs. 4 and 5) the latter is rotated by the worm and through the vertical arbor 13 (Fig. 4) effects the movement of the small idle gear 14 (Figs. 4 and 6). While this gear 14 revolves

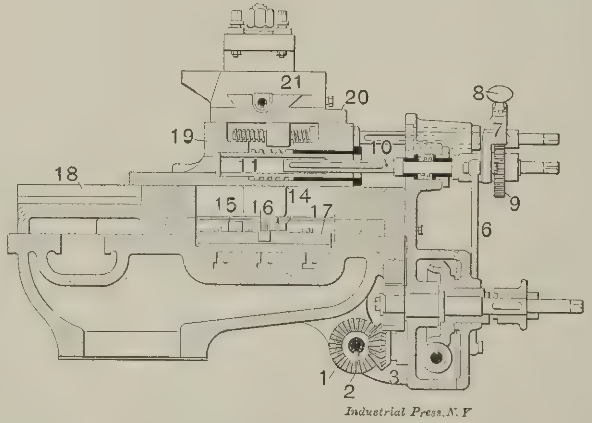


Fig. 3. Cross-section of Carriage.

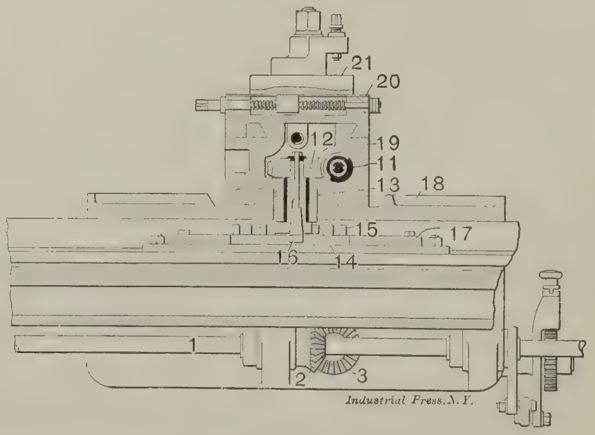


Fig. 4. Longitudinal Section of Carriage.

around the rack 15, made up of a row of pins (Fig. 6), the tracing point slides in the groove of the profile guide 17 and thereby insures the regular movement of the carriage, as well as the proper meshing of the idle wheel 14 with the pins of the rack 15.

The slides 18, 19 (Figs. 2-5) get their movement from the shaft 13. The lower one of these slides (18) runs only lengthwise on the ways, while the other (19) has both lengthwise and cross motion on the first slide (18). The two upper slides (20, 21) are only for adjustment of the tool. All points of the slides 19, 20, 21, and the lathe-tool get the same curved motion as the tracing point.

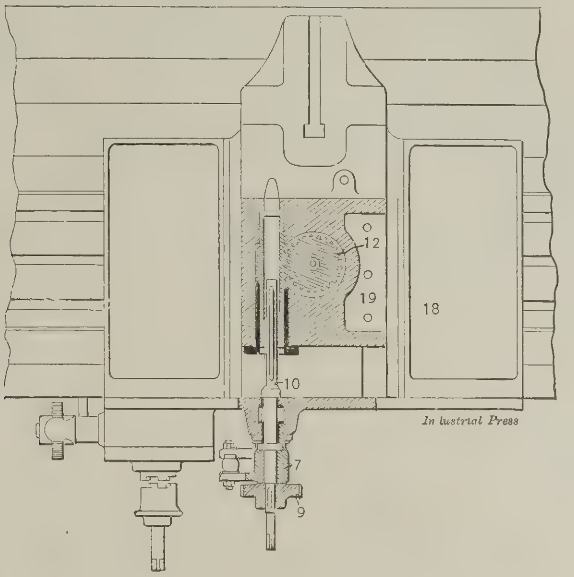


Fig. 5. Plan, showing Further Details of Feed.

To the right of Fig. 1 can be seen the same guide as in Fig. 6, and a parallel-rod stub-end turned to the same outline. The piece on the left is a cam with the standard profile of the Saxon State railway car wheel flanges and the guide therefor.

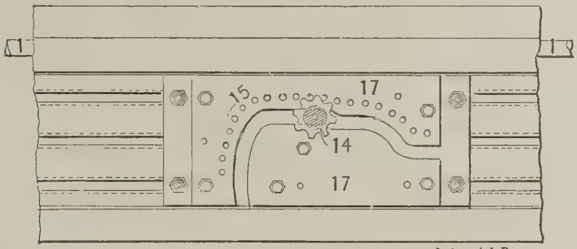


Fig 6. View of Cam or Former.

To use the lathe for ordinary turning, the guide is removed. The gear work (Figs. 2 and 3) can be thrown out by a clutch. To lessen wear of the wedges in the grooves, they have spring bearings. The guides are made of cast iron; the rack 15 of Stubs steel pins.

[The usual method of turning irregular work in the lathe is to use a cam or former in place of the slide of the taper attachment, the cam having a contour corresponding to the shape of the piece to be turned. A roll or pin attached to an extension of the cross slide at the rear of the carriage bears against the edge of the cam and is held in contact with it by means of a weight. Such a crude arrangement, however, is not practicable for the class of work mentioned by Mr. Grimshaw, where the tool must move in or out a considerable distance during a comparatively small travel of the carriage; but the lathe described in this article is adapted for all classes of irregular work, because the cam controls not only the crosswise movement of the cross-slide of the lathe, but the longitudinal movement of the carriage as well. In the case of the ordinary engine lathe having independent longitudinal feed for the carriage, and fitted up with a cam or former in place of the taper attachment, only the crosswise movement is under the control of the cam and the carriage travels ahead at a uniform rate, which at times is too rapid to allow the tool to follow the curvature of the cam. This difficulty is sometimes overcome, as explained by Mr. Grimshaw, by the use of a rotary cam which makes it possible to give the cross-slide a very rapid motion in or out, while the carriage itself is moved ahead with a very slow feed.—Editor.]

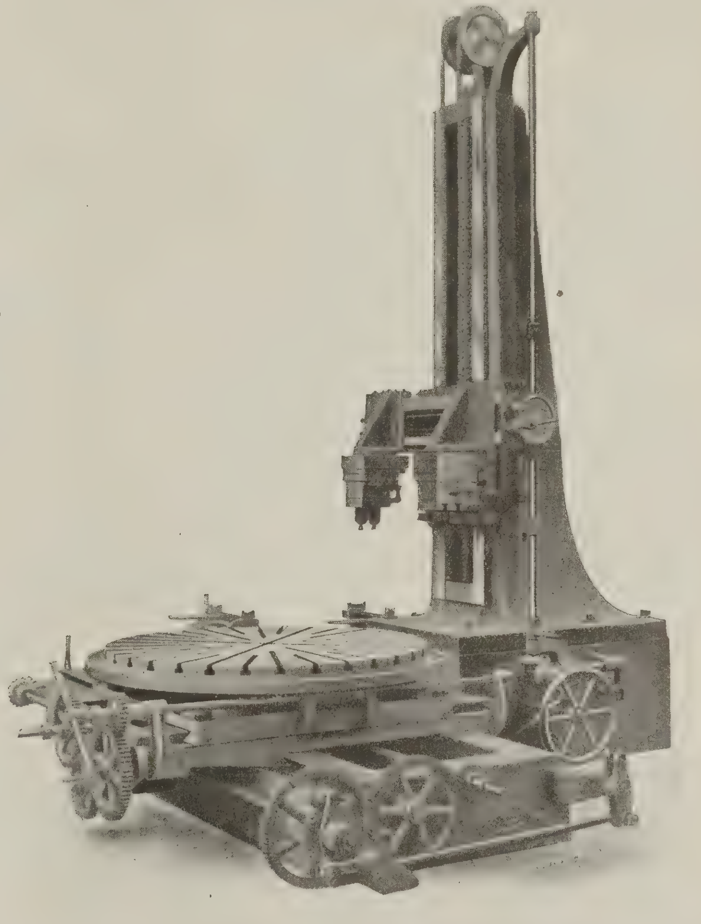
* * *

A LARGE VERTICAL PLANER.

FRANK C. PERKINS.

The English self-acting vertical planing machine below was constructed at Manchester, England, at the Ancoats Works, by John Hetherington & Sons, Ltd. The machine is different in some details, from the familiar slotter, the construction being more nearly in accord with planer design, rather than shaper design, and the tool can rightfully be designated as a vertical traveling-head shaper.

The machine is provided with power and hand feeds in both directions, to the longitudinal, tranverse and circular motions. It will plane up to a height of 9 feet; also to a length of 9 feet. The diameter of the circular table is 6 feet and the diameter of the largest object that can be planed is 9 feet 6 inches. The feeds are independent and may be varied while the machine is in motion.



Vertical Planer, 9 feet Stroke; will Plane Circle 9 feet 6 inches Diameter.

The table can be locked in four positive positions, each at right angles with the adjacent one. The upright is of box pattern and planed to fit the box base. The length of the bed is 14 feet 3 inches. The vertical slide is balanced by two chains. The cross slide, which is attached to the vertical slide, is fitted with two independent, compound, full swivel tool boxes, with hinged spring clappers, for relieving the tool on the return stroke. The clappers are provided with T-slots and double tool posts, with independent, self-acting horizontal feed along the cross slide, which may be varied while the machine is in motion. There is a hand adjustment to the compound slides and adjustable stops for different length of strokes and quick-return motion.

* * *

The Rapid Transit Subway station in New York City will have both reciprocating engines and turbine generators of 5,000 kilowatts capacity. The former are 40 feet in diameter and weigh 980,000 pounds; the latter are only 12 feet 6 inches in diameter and weigh 234,000 pounds, the weights of journals and shaft excluded in each case.

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Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY
DESIGN—CONSTRUCTION—OPERATION
PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS,
66-70 WEST BROADWAY, NEW YORK CITY.

LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JUNE, 1904.

NET CIRCULATION FOR MAY, 1904,—23,897 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

COMPRESSED AIR AND MACHINE TOOLS.

On Saturday, April 30, William Sellers & Co. entertained a number of the engineering fraternity at their works in Philadelphia. The occasion of the gathering was the completion and exhibition of a new type of planing machine in which the reversal of the platen is effected by a pneumatic clutch; and the visitors were also shown other attractive features about the plant, such as the latest types of Sellers injectors, the Sellers electric cranes, semi-automatic tool grinders, etc. An elaborate luncheon was served the guests shortly after their arrival, after which attention was directed to mechanical matters.

The new planer is 100 inches wide between housings, the platen 20 feet long, and the weight of the platen 60 tons. The casting that was on the platen at the time of the exhibition weighed 17 tons. The design of the machine is distinctly novel and original, and we expect to publish a description of it in a later issue. The pneumatic clutch and its method of application, however, by which there is no reversal of the driving pulleys when the platen reverses, and hence the momentum at the points of reversal is correspondingly reduced, constitute the most striking features. The drive is by a 50-horse-power motor belted to the clutch shaft by a single wide belt. The drive is designed to give a constant return speed of 100 feet a minute to the platen, without regard to the cutting speed, and change gears are employed which in this instance are proportioned to vary the cutting speed from 25 to 48 feet a minute. Apparently this plan of maintaining a uniform return speed at what is considered to be a maximum practical figure, and of providing means for changing the cutting speed, is destined to be very successful on heavy work, with high-speed steels. The employment of the pneumatic clutch accomplishes in a simple manner what it has been attempted to do in a few instances by means of the magnetic clutch, but without any trouble from residual magnetism, which has sometimes been a fault of the latter. By using pneumatic pressure to shift the sliding member of the clutch, the reversal occurs instantly and positively, since it is possible, of course, to so design the clutch that the pressure between the friction surfaces of the clutch may be great enough to carry the load without any slipping whatever. This was shown in the facts that the heavy platen, with its heavy load, could be reversed to a line, repeatedly, and with a platen travel much less than a foot.

As far as we know, William Sellers & Co. have introduced a new principle of construction in their machine, and may it not be that with the increasing use of compressed air in our machine shops this principle can profitably be extended to other kinds of machine tools, where the simple turning of a valve in order to produce certain motions would be much simpler and easier for the operator than any mechanically operated device. Machine tools are required to be so heavy to stand up under the heavy cuts and rapid speeds and feeds now demanded, that many manufacturers find it absolutely necessary to provide means for moving the heads, carriages, etc., of their machines by power, even when no work is being done by machine. Moreover, hydraulic feeds are being experimented with as being more desirable for heavy duty, just as the hydraulic press is more desirable than the power-driven press under like conditions. We have recently illustrated a massive hydraulic-feed boring lathe made by the Niles Tool Works; and, to go to the other extreme, it is known that the manufacturer of a type of small lathe has done much experimental work with hydraulic feeds, which shows that the hydraulic principle may be adapted to almost any conditions. In a similar manner, we believe that a pneumatic action, in connection with clutches or other mechanical devices, has a wide range of usefulness yet scarcely realized by designers.

* * *

NOTES AND COMMENT.

A wild panic occurred on the East River ferryboat America on the evening of April 26, when her engineer died at the throttle. As the boat neared the Williamsburg slip the pilot signalled to slow down, but no attention was given it. Again and again was the signal rung, and by this time the boat had bumped into the slip, damaging it and the latter badly, besides injuring a number of passengers. After striking, the vessel rebounded, but the paddle-wheels were running full speed ahead, and again and again she crashed into the piles. The fireman rushed to the engine room and found the engineer dead on the floor, where he had fallen when stricken with heart failure. Where there is only one man in the engine room, as in this case, it would appear that there is need for something on the automatic engine stop order. With such an equipment the pressing of a button in the pilot house would have saved a lot of damage and a bad scare to the passengers. It was fortunate that no worse result was the outcome.

The new Springfield rifle, described in these columns a few months ago, is credited by competent authorities with being the most efficient and durable—or, in other words, the most deadly—army rifle extant. Indications are, however, that those who are making their life work a study of ways and means for annihilating the enemy in the quickest and most effective manner will not long remain content with even this refinement of the gunsmith's art. It has been proposed to use a central steel core in the infantry bullet and even to make a steel bullet, which type as yet has not proved successful. But these improvements will not long satisfy the War Department, for the military world is inclining to an automatic infantry gun similar in principle to the automatic machine gun, but of course with a much shorter duration of fire at one loading of the magazine. If such a gun should be adopted, however, its advantage would not consist so much in its extreme rapidity of fire as in the fact that it would enable the infantry soldier to shoot more effectively at critical times. Extreme rapidity of fire under ordinary conditions is a disadvantage, because it is wasteful of ammunition and would call for an increase in the size of the already cumbersome ammunition trains. The effectiveness of the arm would come from the fact that it would furnish the means of delivering rapidly a comparatively small number of shots without taking the gun from the shoulder. This would increase the chances of hitting a small or obscure target at a considerable distance, because the soldier could fire a succession of shots without loading his piece or changing his aim. It would give him an opportunity to land several shots very close to the mark.

THE COLUMBIA BICYCLE TWO-SPEED GEAR.

A COMBINED FREE-WHEEL, BRAKE AND SPEED CHANGING MECHANISM.

Last year the Pope Mfg. Co., the well-known bicycle manufacturers, brought out a two-speed gear in combination with their Columbia bevel gear drive, coaster or free-wheel and back-pedal brake. This ingenious device, which is almost entirely confined within the limits of the rear hub barrel, is presented herewith as an interesting example of a mechanism that performs a number of functions semi-automatically, there being no resort to the use of manipulating levers save those by which the bicycle is propelled, i. e., the pedals. These are moved in a backward direction to bring about the changes, as will be explained. With this gear it is possible: 1. To drive at low gear (68). 2. To coast from low gear, that is, let the wheel run freely of its own volition without working the pedals. 3. To apply the brake from low gear position. 4. To change from low to high gear (92), or *vice versa*. 5. To drive at high gear. 6. To coast from high gear. 7. To apply the brake from high gear.

The rear hub is shown in section on a horizontal plane with all the parts assembled, in Fig 1. The driving shaft, which is concealed within the right lower member of the frame, carries at its rear end the two bevel gears, L_1 and M_1, the low and high driving gears respectively. The low gear mechanism can be dismissed in a few words, as it is relatively simple. It should not be inferred from this statement, however, that the remaining mechanism is excessively complicated, for such is not the case. While there are many parts, the action is quite simple and easily followed with the aid of the detail drawings shown in Figs. 2 to 6, inclusive.

In the first place it will be noted that the low gear D_1 is mounted on a sleeve *Y*, which is apparently grooved for three ball races. There are properly, however, only two ball races, these being for the balls *b* and *c*. The right ball race *b*, with the corresponding race *b* on the left, form the free-wheel bearings when coasting. The ball race *c* takes care of the difference in motion between the low gear sleeve *Y* and the high gear sleeve *Z*. The low gear sleeve is thus held between an exterior and an interior ball race and these form its principal supports. What is apparently the third ball race is really a ball clutch, there being four balls, of which *e* is one. The interior of the hub barrel, on this transverse plane (also at the opposite end), has eleven notches or teeth milled with their sides in one direction more steeply inclined than the opposite sides. This may be seen in A_1, Fig. 2. In *Y*, Fig. 3, it will be seen that the low gear sleeve has four holes or pockets drilled tangentially to a small circle concentric with the exterior. These holes form the retreats of the balls when the wheel is running free or when being driven by the high gear. When the low gear is driving, one of the four balls is engaged between the low gear sleeve and the side of one of the eleven interior clutch teeth, and thus transmits motion to the wheel. There being four balls and eleven clutch teeth, it follows that there are forty-four locking positions in one turn of the sleeve. This also applies to the high gear sleeve. The simplicity of the low gear action lies in the fact that it acts only when the

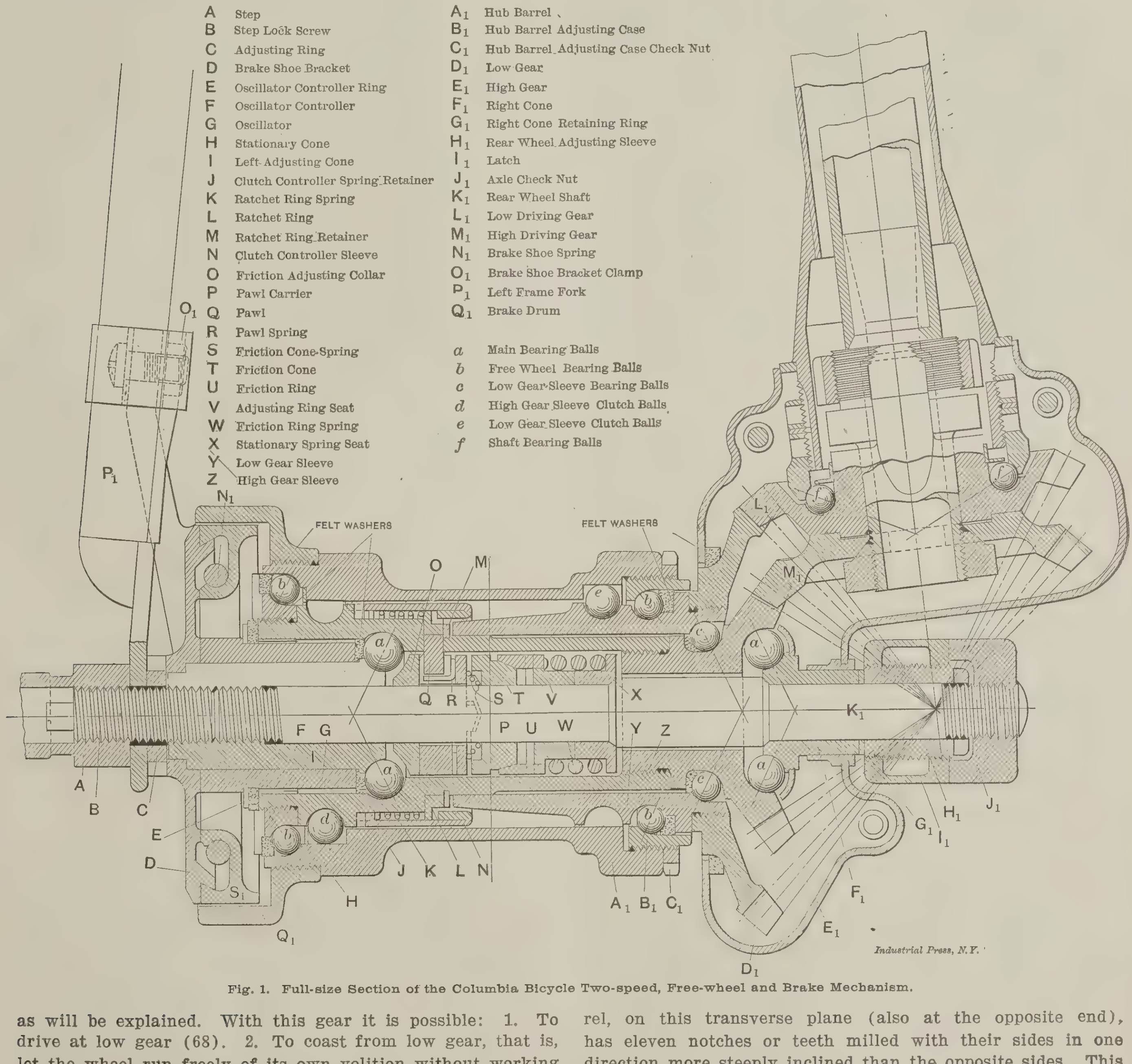


Fig. 1. Full-size Section of the Columbia Bicycle Two-speed, Free-wheel and Brake Mechanism.

Industrial Press, N.Y.

high gear is restrained, and, therefore, it merely requires a simple clutch that shall release when moved backward, either actually or relatively to the hub.

The high gear sleeve engages the hub barrel by a similar ball clutch, one of the balls being shown at *d*. The disposition of the pockets for the balls in the high gear sleeve is also the same, as will be seen from the sections shown at *Z*, Fig. 3. Now since the sleeve *Z* runs at a higher rate than *Y*, it follows that its clutch would always be the one driving the wheel unless means were provided to prevent the clutch balls acting when desiring to drive at low gear. The immediate means provided is a shutter *N* called the clutch controller sleeve, which is also shown in detail at *N*, Fig. 3. This sleeve has four fingers, j_1, which engage in four grooves milled in the high gear sleeve in line with the ball pockets, as indicated at *j*. When this shutter is moved to the left, it imprisons the balls within their pockets and prevents any clutch action. The way in which this shutter is operated in order to change from high to low gear and *vice versa* is as follows:

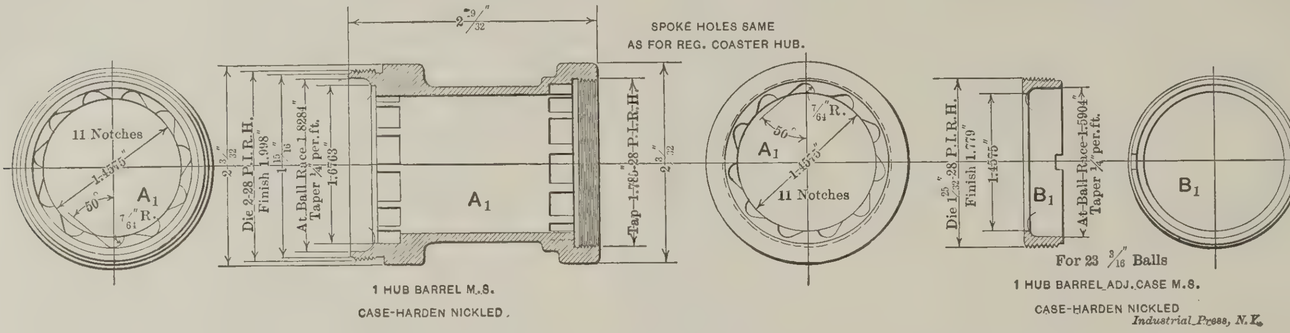


Fig. 2. Details of Hub Barrel and Adjusting Case, showing Notches for Clutch Balls. One-half full size.

First we must understand that the pawl *Q*, the pawl carrier *P* and the friction cone *T* rotate forward with the high gear sleeve *Z*. They drag slightly because of the friction of the friction cone *T* which is forced into the seat in the friction ring *U* by the pressure of the light spring *S*. When the rider wishes to change the gear, he stops pedaling forward and reverses the pedals slightly, in other words, moves them backward such a distance as experience has taught—a small fraction of a turn. The backward movement of the high gear sleeve *Z* is not at once communicated to the pawl and pawl carrier because the slot in the sleeve *Z* is somewhat wider than the pawl. The backward movement of *Z* is, however, instantly transmitted to the clutch controller sleeve *N* since the fingers j_1 fit closely in the slots. The sleeve *N* tends to turn the ratchet ring *L* with it, but the pawl *Q* engages one of the teeth on its inner surface and stops its movement momentarily.

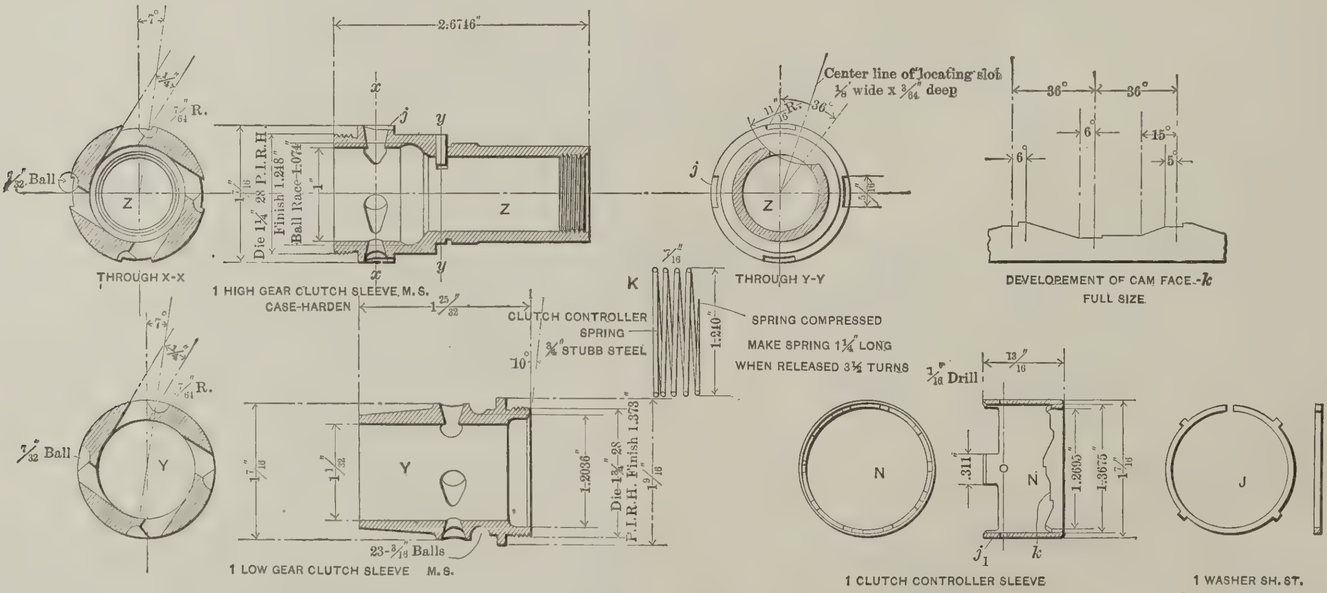
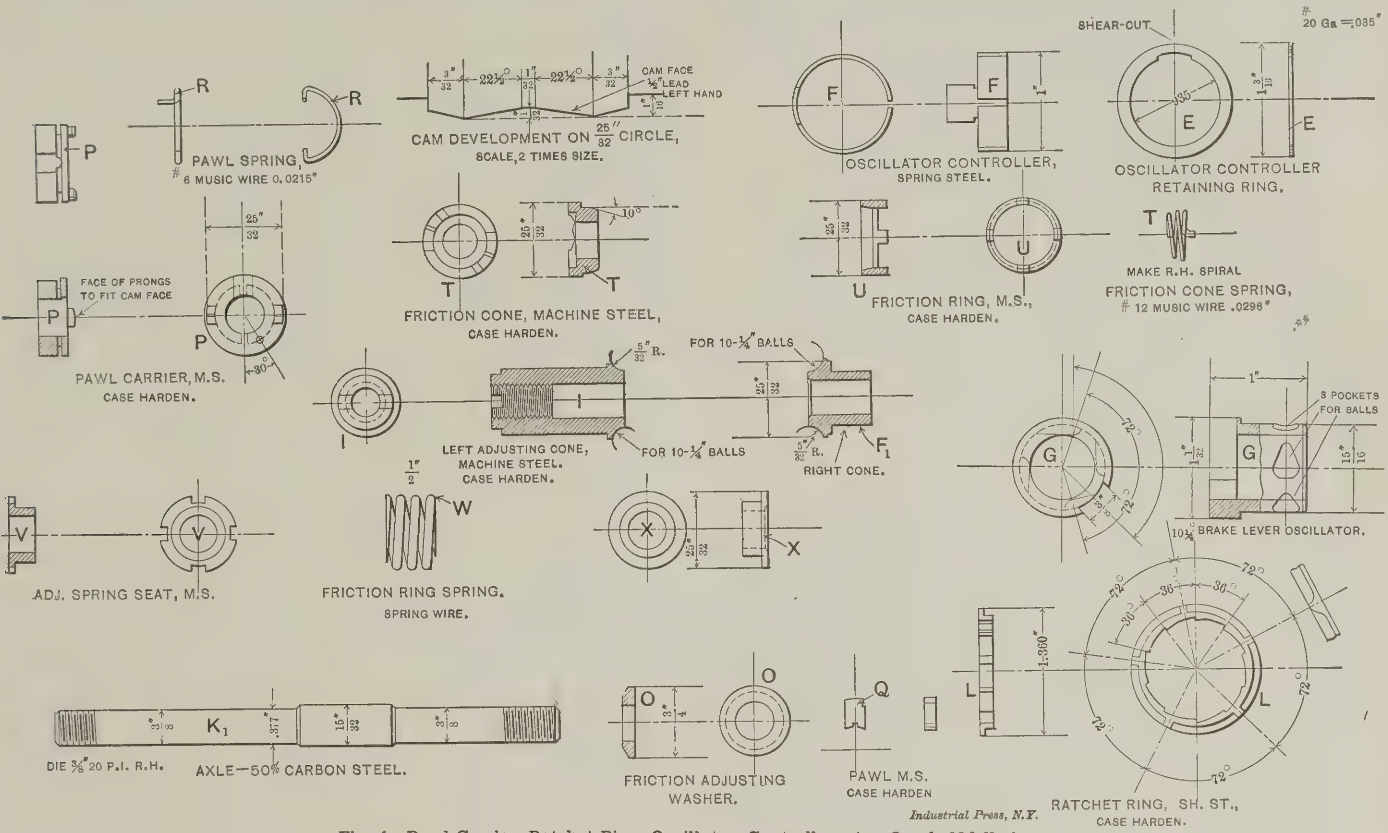


Fig. 3. Details of High and Low Gear Sleeves and Clutch Controller Sleeve. One-half full size.

The ratchet ring also has teeth cut on the right side, as may be seen at *L*, Fig. 4. These teeth are always in contact with cam faces, cut in the interior of the right end of the clutch controller sleeve *N*, being held together by the coil spring *K*. Now if the rider has been pedaling the high gear, the backward movement of the clutch controller sleeve moves the interior cam faces over the face of the teeth cut in the side of the ratchet ring, into such a position that the shutter sleeve is free to move to the left and shut the four clutch balls *d* within their pockets. Then the forward movement of the pedals brings the low gear sleeve into clutch action with the hub barrel, and he travels forward in low gear. The high gear sleeve *Z*, meanwhile, rotates at a higher speed, but idly, since its clutch balls are restrained from acting, being shut within their pockets, as just explained.

Should the rider again move the pedals backward, he will change to high gear again for the reason that a second movement of the interior cam faces of the clutch controller sleeve *N* over the side teeth in the ratchet ring forces the controller sleeve to the right and releases the clutch balls. The moment these are free to act, driving in low gear can no longer continue. Thus each backward movement of the pedals changes from high to low gear, and *vice versa*. Suppose, for instance, the rider has been working the pedals in high gear on a level stretch of road, and has come to the foot of a hill. He throws the machine into low gear, and climbs the hill. Having reached the summit the wheel is allowed to run freely down the opposite side until its velocity must be checked, and then an extreme backward movement of the pedals forces the brake into action, as will be explained later, and reduces the speed. At the foot of the grade pedaling is resumed in high gear, the change from low to high gear having been effected incidentally with the application of the brake.

Before describing the action of the brake it is advisable to go back and explain more fully the action of the pawl and pawl carrier when holding the ratchet ring stationary so as to change the clutch controller position. As already stated, the pawl, pawl carrier and friction cone run with the high gear sleeve, dragging backward slightly all the time. But the drag or resistance is so slight that it would be totally inadequate to check the backward movement of the ratchet ring were it not reinforced in some manner momentarily; that is, when the ratchet ring starts backward the resistance of the pawl carrier must be made several times what it is normally, but this increased resistance must disappear the moment the ratchet ring has changed the position of the shutter sleeve. The way in which the resistance is momentarily increased is as follows:



Industrial Press, N.Y.

Fig. 4. Pawl Carrier, Ratchet Ring, Oscillator, Controller, etc. One-half full size.

The pawl carrier *P* has two fingers on the right side which terminate in cam faces and these fit into corresponding faces on the left side of the friction cone *T*. In one direction the sides of the fingers abut against shoulders on the friction cone and carry it forward positively. But when the pawl carrier is moved backward the cam faces slide by one another as their angles and distance from the center of rotation are such that resistance to sliding movement at this point is less than that between the friction cone and friction ring. At the right is a stiff coil spring *W*, held between two collared washers *V* and *X*, each of which is a driving fit upon the axle. The washer *V* has four slots milled in its collar, into which project four fingers from the right side of the friction ring *U*, so that their ends are flush with the right side of the collar on *V*. The spring *W* normally rests against this collar so that movement of the friction ring to the right is at once resisted by the spring. When movement begins between the cam faces on *P* and *T* the spring *W* is compressed and the reaction forces the pawl carrier against the side of the friction adjusting collar *O* with considerable pressure, greatly increasing its frictional resistance to rotation and causing the ratchet ring to do its work. But it is necessary to provide for further backward movement of the high gear sleeve than would be possible if the pawl carrier locked tighter and tighter with further backward movement. So when it has accomplished the movement of the ratchet ring within the clutch controller sleeve, it must release its grip and move backward freely. It is for this reason that the spring *W* is provided. The compression of the spring gives the necessary resistance and it also allows the cam faces to slide by the high points and to drop into the corresponding low points on the opposite sides. See details of *P* and *T* and development of cam faces in Fig. 4. Then the pawl carrier is free to move backward with the high gear sleeve, for the application of the brake. When the sleeve again moves forward the cam faces slide by into the former position so as to be in place for operating the ratchet ring again when required.

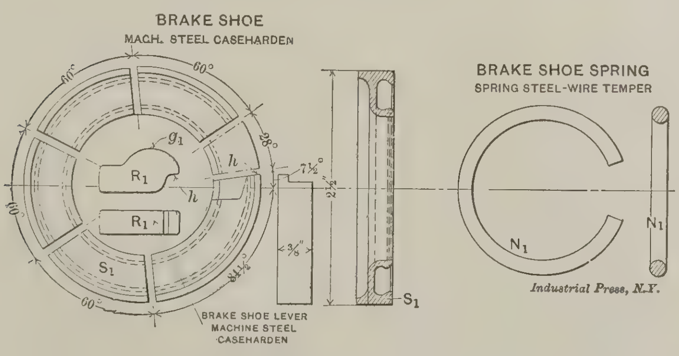


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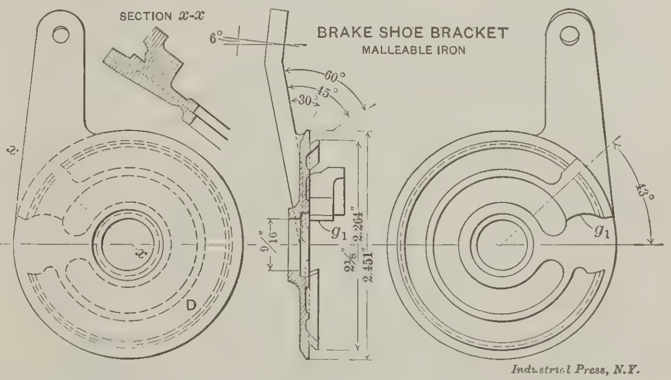
Fig. 5. Brake Shoe and Brake Shoe Spring. One-half full size.



Industrial Press, N.Y.

Fig. 6. Brake Shoe Bracket. One-half full size.

As already stated, the extreme backward movement of the high gear sleeve forces the brake into action. This movement is first communicated to an oscillator, *G*, by means of the four clutch balls *d*. The holes for these balls in the high gear sleeve allow them to reach the surface of the oscillator, and in this path there are milled three shallow pockets in the periphery of the oscillator, as may be seen in detail at *G*, Fig. 4. These pockets allow the balls to go into clutch action with the high gear sleeve at twelve points in the circle, there being three pockets in the oscillator and four equally spaced balls. The backward movement of the oscillator is communicated to the brake lever R_1, Fig. 5, which in turn opens the segments of the brake shoe within the drum and forces them against its inner wall. The rounded surface of the brake lever rests against the rounded recess g_1 in the shoulder on the brake shoe bracket D with the finger h between the ends of the brake shoe segments. The proportions are such that a heavy braking effect is developed with a comparatively easy backward pressure on the pedals. When the backward pressure on the pedals is removed the spring N_1 instantly contracts the segments and releases the brake. The object of the oscillator controller is to provide a slight frictional resistance to its movement so that it will remain closely in contact with the brake lever.

* * *

HIGH-SPEED TOOL STEELS.

PRACTICAL SUGGESTIONS FOR THEIR TREATMENT.

WALTER BROWN.

For several years this subject has been much talked of, but until lately not a great deal had been accomplished. Even now high-speed steel is only in its infancy, manufacturers being constantly under the necessity of experimenting and changing the constituents to secure better results. Even the best yet produced will have occasional hard streaks when annealed to its softest state; and flaws are of frequent occurrence. Another disadvantage is its greater hardness, compared with carbon steel.

In spite of its shortcomings, however, it is very evidently the cutting-tool material of the future, both because of its superior qualities, all things considered, and of the likelihood that most of its present failings will be overcome as manufacturers get a better knowledge of its nature and behavior.

The chief difficulty in the way of its use now is its exceeding brittleness. Many a user has become discouraged with the result of a few experiments and has, because of finding that it lacked the toughness of other steels, discarded its use entirely. More experience would, if intelligently obtained, have demonstrated without question the great value of this new product of the metallurgist's skill. The question of brittleness is largely a question of treatment; and intelligent experience will very largely obviate the difficulty so that it will be tough enough to stand up under any proper conditions of work. Every tool dresser knows how to handle carbon tool steels, and is guided by his knowledge of their qualities at different temperatures as indicated by their varying colors. When he gets a high-speed steel he naturally treats it much as he would carbon steel. This is where most of the trouble begins. The smith must learn an entirely different set of color values and methods of treatment. He thinks that if he has succeeded in getting a hardness greater than that of his file, he has done his job. That, however, has nothing to do with the fitness of the tool. I have known cases (with a certain make of steel) where the tool would do the best work while still soft enough to take a good Swiss file. In other steels a similar degree of softness, or even a degree of hardness much greater than that of ordinary steel would not work, the tool "gumming up" and rapidly burning up. The whole secret lies in getting the tool to such a heat, in the process of hardening, that the constituent molecules are mobile, and then "drawing" it to the right point. When the toolmaker has mastered this secret, he can produce a tool of high-speed steel as tough as any of carbon steel. The mastering of it is largely a matter of experience. Our own experiences have been so interesting and successful that I have thought they might prove of help to others, and I submit them herewith.

The tools should be placed in a pipe or box, well surrounded with small pieces of coke, the packing case then being sealed up with fire clay. Small holes must be left for the escape of gases, otherwise the clay will blow out. The heating furnace should have been previously heated to a white heat. The packing case is left in the heat from one to three hours, according to size. When removed from the furnace, the box should be as near the bath of fish oil as may be, so that there will be no unnecessary delay in bringing from the gases of the packing case to the bath. Exposure to the air not only causes scale, and therefore variation in size, but tends to affect the precision of the hardening process. Observance of this caution will prevent a variation of more than a thousandth of an inch in tools of moderate size. Carbon steel usually varies several thousandths as a result of hardening.

The method of packing will depend somewhat upon the shape of the tool. It is important to pack in such a way that all tools packed in one case be so placed as to be handled very quickly, and at once plunged into the bath, to prevent scaling by reason of contact with the air, as explained above. In case of milling cutters and key-seat cutters, a good way is to suspend them all from a rod, each separated from its neighbors by a slight space, sufficient to allow a free circulation of oil when plunged. Neglect of this caution will be very likely to cause cracks, from the unequal contraction of the cutters, the outer edges only being brought into immediate contact with the bath, and therefore shrinking more rapidly than the interior parts.

For taps, drills, and similar shaped tools, this hardening leaves the steel too brittle, and as soon as the tool has become a little dull it breaks off. To avoid this the tool can be drawn as can a carbon steel tool. But here, too, a new set of color scales must be learned. The blue heat of carbon steel is not enough for the high-speed steel. The heat must be carried on until the metal reaches a greenish tinge. It is then allowed to cool in a dry place free from air drafts.

It is now much tougher and softer than before. In case it needs still further softening, it can be done by reheating, bringing it to a faint red, dull enough to be perceptible only in a dark place (an empty nail keg is convenient for this use) and then cooled as before. We have made taps as small as 5-16 inch in diameter to be used in an automatic nut tapping machine, about the hardest work to which a tap can be put, with gratifying results. In the test three taps cut 92.000 nuts, an average of almost 31,000 nuts per tap; with carbon steel taps we cut 6,000 nuts per tap. No effort was made to speed up the machine, the test being one of durability only. The carbon steel taps cost about ten cents, and the high-speed taps about forty, or four times as much. The latter, however, cut about five times as many nuts. Besides this, there is also to be taken into account the more important saving in the time used formerly for stopping the machine, and removing and grinding taps, which is five times as great when carbon steel taps are used. This is not mentioned as a particularly demonstrative test, but merely to show that high-speed steel can be profitably used for small tools, if properly treated. Another place where we are using high-speed steel with profit and satisfaction in small tools is in drills. The saving here is very marked; but the statements and claims of several makers of such drills is not verified by our experience. We find that we can run such a drill at about double the speed of the ordinary drill, and at the same time cut more holes.

Makers of the new steels are in the habit of making large claims as to speeds attainable. We have tried about every such steel on the market, giving each a thorough test. Our experience usually bears out the moderate statements, and sometimes the extravagant ones put forth by some makers as to what is possible. For instance, we have cut a 1-16 chip, 1-32 feed, at a rate of 266 feet per minute peripheral speed, from a rod of machine steel. Such speeds are possible for short periods; but whoever buys a rapid cutting steel with the expectation of maintaining such speed will be sadly disappointed. With a fine feed, even four hundred feet per minute can be cut under very favorable circumstances. But think of the chip that comes off! In case of steel the chip is no such thing as we are accustomed to, breaking into short pieces and dropping into the box below. At a speed of, say, two hundred feet per minute, the chip comes writhing and twisting, almost red hot, in a continuous length, shooting here and there, everywhere but the chip box; and quick must be the workman that manages to keep well out of the way of it, for it "sticketh like a brother" when once he gets tangled in it. Possibly, in time, a way will be found to take care of such chips. Until this is done, however, a moderate speed is most desirable. We find that on steel, where there is no considerable thickness of metal to remove, a speed of one hundred feet a minute is very satisfactory. This allows taking care of chips, and the tools stand up well under it. In turning gray iron, where the scale is to be removed, about seventy feet per minute is giving us the best results. Naturally, however, there being so many different kinds of materials to work up, and each one of these varying more or less themselves, there can be no set rule for speed. Each job will work out a rate for itself. The main thing is to get out the job as fast and as well as possible, and at the same time to lose as little time as may be in grinding the tool.

Another word about the saving to be effected. This will depend among other things upon the number of machines that are run. If only one machine runs on a job, there will not be a saving of two-thirds simply because the speed is trebled. It must be remembered that perhaps fifty per cent. of the time for doing a job on a single machine is used in jigging the piece and setting the tool.

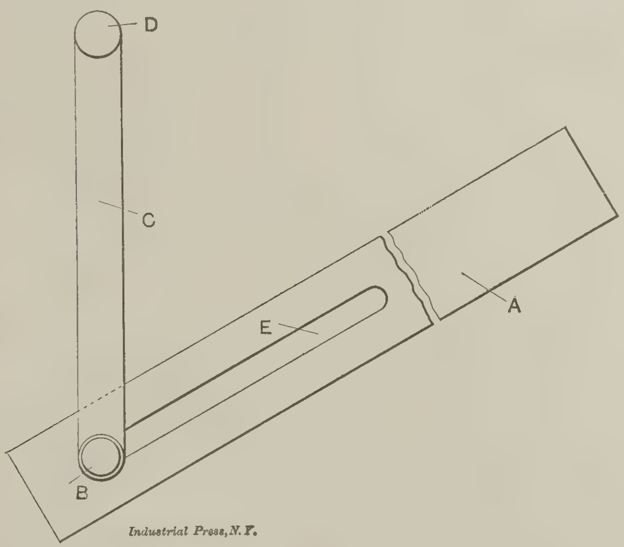
The high initial cost of the new steels has made it necessary to devise means for reducing the quantity of metal in the tools used. The result has been the production of some very ingenious schemes for holding cutters. The lathe tool holder is, of course, familiar to all. Milling cutters, hollow mills, and reamers with inserted teeth are scarcely less familiar. It is now true that we are making all these tools with inserted cutters of rapid cutting steel at less cost than the old carbon steel tools. At the same time they are doing from three to ten times the work, and at a much greater speed.

* * *

THE ECCENTROLINEAD.

M. S. SMITH.

At some time or another there will come to every draftsman an occasion to use an instrument called the "eccentrolinead." Primarily, this instrument consists of a long straight-edge *A*, Fig. 1, which is swung from a clamp nut *B* on a metal arm *C*. Sometimes the clamp nut *B* moves in a slot *E*, so that the straight-edge *A* can be extended at will in either direction from *B*. In the end of the arm *C* is the needle point *D*. By means of the clamp nut *B* the angle between the straight-edge *A* and the arm *C* can be varied at will.



Industrial Press, N. Y.

Fig. 1.

Its usefulness lies in the fact that with it can be drawn a system of lines, each at any given angle with a radius to that line, and passing through the common center of the system. Fig. 2 illustrates the principle just stated. In this case the line *AB* is the line drawn by the straight-edge when it has been set to the angle a with the radius to this line. The radius represents the arm of the eccentrolinead.

It is readily seen that by varying the angle between the arm and the straight-edge, any regular figure desired can be drawn.

Fig. 3 illustrates its use in the laying out of tangent lines, as the spokes of bicycle wheels. Its chief advantage, however, lies in the ease and accuracy with which this kind of lines can be drawn when they are very short and numerous. The writer has in mind the drawing of a unique ratchet. The teeth of this ratchet were on the inside of a hollow steel gear, Fig. 4, whose inside diameter was 2¼ inches, and which contained 32 teeth.

The depth of these teeth was about 1-16 of an inch and the angle between the sides of the teeth was 90 deg., the radius to the bottom of the tooth bisecting this angle. These conditions made the length of the side of the tooth from top to bottom somewhat less than ⅛ of an inch. It is readily seen that to lay out these lines by stepping off points with the dividers, and to do it accurately, would be difficult, to say nothing of being very laborious.

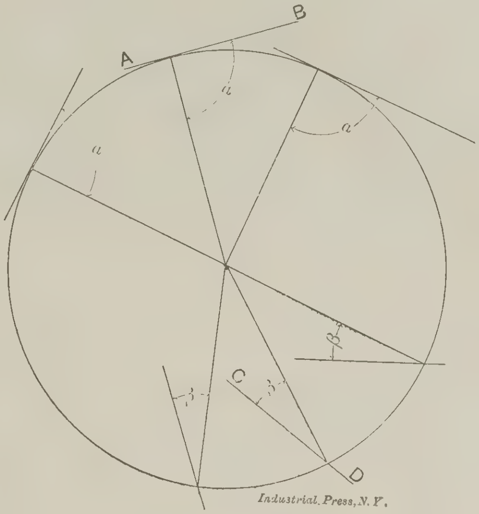


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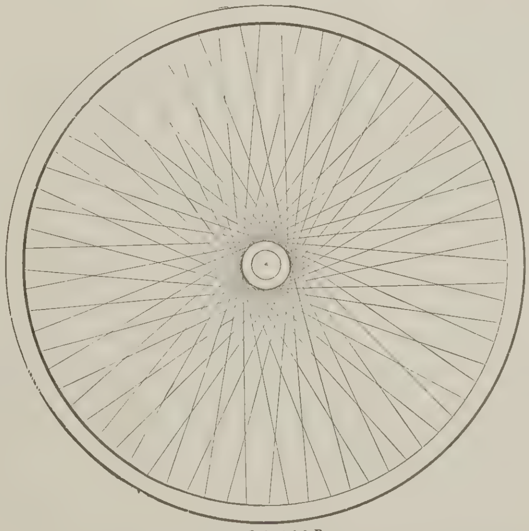
Fig. 2.

With the eccentrolinead it becomes very simple—two circles are drawn respectively for the tops and bottoms of the ratchet teeth and the pitch is laid out on the circle representing the bottoms of the teeth. Care being taken to start the pointing off for the pitch from the intersection of the horizontal center line and the circle representing the bottom of the teeth. A long 45 deg. line is then drawn with the triangle and T-square from this intersection. The Eccentrolinead is set once for all to this line. After this, all that is necessary is to revolve the straight-edge to the next pitch point, and the line drawn will be 45 deg. from the radius to that point. This operation is repeated for each pitch point on the circle when one side of each tooth will have been drawn. The other side of the tooth is laid out in a similar manner.



Industrial Press

Fig. 3.

This is only one case of many, and as may frequently happen, the sides of the tooth may not come exactly at the angles obtained from the common triangles, but in any case for a series of lines each of which makes the same angle with its respective radius, only one setting of the instrument is required, thus greatly shortening the work, and in the case of very short lines, greatly increasing its accuracy.

However, the eccentrolinead costs from three to four dollars, an element, which, considering the comparatively small use for the instrument, has kept it out of the hands of many draftsmen.

The following is a homely substitute which can be prepared in a moment by any one possessing a triangle and a bit of tracing cloth or heavy tracing paper. It is the eccentrolinead possessed by the writer and which he has used at divers times to excellent advantage. The accompanying illustrations were drawn with this substitute for the eccentrolinead.

Paste the tracing cloth firmly on one side of the triangle and when the direction of one of the series of lines to be drawn has been determined, place the edge of the triangle along this line in such a position as to bring the center of the series of lines within the opening of the triangle, being careful to have the side of the triangle on which the tracing cloth has been pasted next to the drawing. When the triangle has been properly placed take a fine needle and drive it firmly through the tracing cloth and into the center of the series. The triangle can then be revolved about this center and in every position will give a line which makes an angle with a radius to a point on this line equal to the angle between the original line and the radius to its corresponding point.

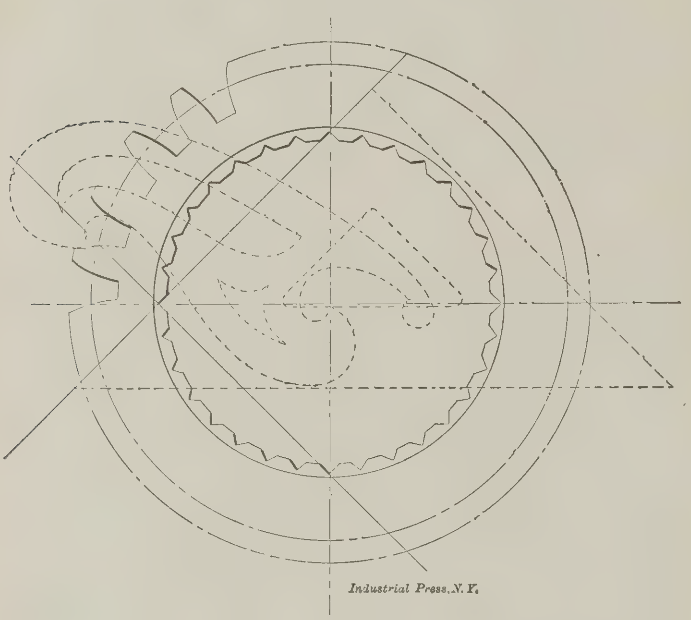


Fig. 4.

Not only the triangles may be used to good advantage by means of this little "stunt," but also the irregular curves. Any series of curves whose curvature throughout the series is the same, and whose position relative to a common center is the same, may be drawn very easily by the above method with an irregular curve.

I know of no better illustration than the drawing of the profiles of gear teeth, Fig. 4. The pitch of the teeth is stepped off on the pitch circle and the profile of one tooth is accurately drawn. Of course, we must have an irregular curve which fits this profile. If this is not possible, the profile may be laid out on a piece of bristol board and carefully cut. The curve in either case is used in the same manner as the triangle.

There are, doubtless, many different ways of applying the principle of the eccentrolinead which space will not permit of mentioning here. The writer, however, will be highly gratified if the principle laid down in the above will be of service to any of his fellow draftsmen.

* * *

TABLE FOR COMPUTING THE COST OF CASTINGS.

W. W. BIRNSTOCK.

The following tables are based on data derived from three successive heats using the average amount of material used, and the average amount of good castings obtained, there being no losses. In these heats it was found that there was an actual melting loss of 6 per cent. of the material charged. A ton (2,240 lbs.) will therefore net 2,100 lbs. of castings, and this weight is used in the following calculations.

1 ton of iron 2,240 lbs. less 6 per cent. melting loss = 2,100 lbs.

Cost of Pig Iron.		Cost of Coke.		Cost of Coal.	
When Cost of 1 ton (2,100 lbs.) is	Cost per lb.	When Cost of 1 ton (2,000 lbs.) is	Cost per lb.	When Cost of 1 ton (2,240 lbs.) is	Cost per lb.
13.50	.00642	4.00	.002	5.50	.00245
13.75	.00654	4.10	.00205		
14.00	.00666	4.25	.00212		
14.25	.00678	4.30	.00215		
14.50	.0069	4.35	.00217		
14.75	.00702	4.40	.0022		
15.00	.00714	4.50	.00225		

In the following example is used the actual figures taken from the average of the three heats.

Example: What is the cost of 11,938 lbs. castings per 100 lbs? Pig at $13.50 per ton (2,100). Coke at $4.00 per ton. Coal at $5.50 per ton. ⅛ cordwood $6.00 Using 1,584 lbs. coke, 400 lbs. coal, 12,708 pig iron.

12,708 lbs. pig at .00642 per lb.	$81.585
1,584 lbs. coke at .002 per lb.	3.168
400 lbs. coal at .00245 per lb.	.98
⅛ cord wood at $6.00 per cord	.75
	$86.483

Then 11,938 lbs. castings cost $86.48 without molders' labor. Then 100 lbs. castings cost $.724 without molders' labor.

Table showing cost of 11,938 lbs. castings per 100 lbs., using 12,708 lbs. pig iron, 1,584 lbs. coke, 400 lbs. coal, ⅛ cordwood at different prices of iron and coke per ton, using, however, the same amount of coal and wood for bed in each instance.

Pig Iron per ton.	Coke per ton (2000 lbs.)	Castings per 100 lbs.	Pig Iron per ton.	Coke per ton (2000 lbs.)	Castings per 100 lbs.
13.50	4.00	.7244	14.50	4.00	.7755
13.50	4.10	.7250	14.50	4.10	.7761
13.50	4.25	.7260	14.50	4.25	.7771
13.50	4.30	.7264	14.50	4.30	.7775
13.50	4.35	.7266	14.50	4.35	.7777
13.50	4.40	.7270	14.50	4.40	.7781
13.50	4.50	.7277	14.50	4.50	.7788
13.75	4.00	.7372	14.75	4.00	.7883
13.75	4.10	.7378	14.75	4.10	.7889
13.75	4.25	.7388	14.75	4.25	.7899
13.75	4.30	.7391	14.75	4.30	.7902
13.75	4.35	.7394	14.75	4.35	.7905
13.75	4.40	.7398	14.75	4.40	.7909
13.75	4.50	.7405	14.75	4.50	.7916
14.00	4.00	.7499	15.00	4.00	.8010
14.00	4.10	.7506	15.00	4.10	.8017
14.00	4.25	.7515	15.00	4.25	.8026
14.00	4.30	.7519	15.00	4.30	.8031
14.00	4.35	.7522	15.00	4.35	.8033
14.00	4.40	.7526	15.00	4.40	.8037
14.00	4.50	.7533	15.00	4.50	.8043
14.25	4.00	.7627			
14.25	4.10	.7634			
14.25	4.25	.7643			
14.25	4.30	.7647			
14.25	4.35	.7650			
14.25	4.40	.7654			
14.25	4.50	.7662			

It is customary in the use of this table to add 15 per cent. to the cost of 100 lbs. of iron as given for such items as cost of cupola tender, cores, sand cleaning, buffing, etc.

For figuring the selling price of castings, the above tables are used by founders in the following manner:

Example: For what price can be furnished a casting weighing 1,242 lbs. requiring 12 hours molders' time at 30 cents per hour, prevailing price of iron $13.75 per ton (2,100 lbs.), coke $4.25 per ton (2,000 lbs.)?

1,242 lbs. at .84962 (.7388 + 15 per cent.)	$10.55
12 hours molding at .30	3.60
	$14.15
Add for office expenses in this example 15 per cent.	2.12
	16.27
To this amount add your desired profit in this example 25 per cent.	4.07
	$20.34

* * *

If the writer from Troy, N. Y., who wrote referring to the note on the old Burden water wheel which appeared in the May issue, will kindly send his name and full address to the editorial office, we will be pleased to explain the matter to him by mail.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The *Engineering Record* says that Prof. Weyrauch, of Stuttgart, Germany, exhaustively investigated the specific heat of superheated steam over an extended range of temperature in 1876, and though it may not be generally known, he advanced proof at that date that the specific heat at constant pressure is not constant, but follows a formula of which the following is the equivalent:

$C = 0.4237 + 0.0002099\,T$, in which

C = specific heat at constant pressure,

T = temperature of steam in degrees F.

An interesting and perhaps valuable application of electricity is reported from the other side where it is said that the firm of Davis & Perrett, London, has used it for the separation of oil from feed water. No details are at hand save that the oily water flows through a narrow wooden trough divided into three compartments and in doing so passes between iron electrodes. A difference of potential of 50 volts is contained between the plates, and 150 volts between the three in series. The inference is that the oil collects on the electrodes, but this is not stated. The result claimed is the separation of the oil from 2,000 to 3,000 gallons of water hourly for an electrical consumption of about 20 amperes. The oil in the water was reduced from 1.07 to 0.01 grain per gallon.

The past month marked the sixtieth anniversary of the practical operation of the electromagnetic telegraph, it being May, 1844, when Prof. Morse was able to demonstrate the use of his invention in reporting at Washington the proceedings of the Whig Convention at Baltimore. The amount of service rendered to the public by the telegraph sixty years after its inception may be judged from the fact, as stated by the *Electrical World and Engineer*, that in only four or five of the leading countries, 400,000,000 or 500,000,000 messages are dispatched annually, exclusive of those handled by private lines. In this country the record is probably about 100,000,000 a year, while Great Britain does not fall very far behind. Germany and France together dispatch another 100,000,000, while Russia, Italy, Austria, and Spain will probably account for another 100,000,000.

A few illustrations of the uses of pneumatic tools in the Indian railway shops recently appeared in the *Indian and Eastern Engineer*, showing the native workmen in turbans and characteristic dress. Whatever may be the limitations of these people in the way of handling tools and machines, they apparently are not slow in the matter of boring cylinders, if having two jobs going at the same time counts. One of the views alluded to shows a double cylinder boring rig at work. The cross shaft, to which the air motor is attached, carries two worms meshing with the worm wheels upon the boring bars. Of course the construction of the British type locomotive with inside cylinders makes it more feasible to bore both cylinders at the same time, but nevertheless we think it is a job that would worry many of our American railway machinists, especially when the cylinders are hard and badly worn out of round.

It appears that the old-fashioned sport of "riding down hill" is elevated to the dignity of an art at St. Moritz in the Alps where, on a perilous toboggan slide, experts vie with one another in covering the course in the shortest possible time. Since only one toboggan can be on the slide at once, it was necessary to rig up an accurate timing arrangement that would show within one-tenth second how long was taken from start to finish. The whole arrangement is simple and is described in a recent issue of the *Electrical Review* (London). It makes use of a chronograph which is started and stopped by the breaking of cotton threads stretched across the slide at the start and finish points, these threads being connected to electric switches to make and break the current. The toboggan slide drops a vertical distance of 600 feet in a little over three-fourths mile, and it has been covered in the breathtaking time of 61 3-10 seconds for the whole course, which means a speed of over 60 miles an hour for the swiftest parts of the slide.

We have previously referred to the property of calcium carbide of quickly generating acetylene gas when immersed in water and its proposed use for compressing cotton, etc.; also its use for giving buoyancy to submarine boats. A still more novel use is that to which it is put in the Gros life belt as described in a recent consular report. The Gros life belt is composed of a series of four small, flat sacs, circular in shape and connected by a tube. The belt is worn in such a manner that it passes under the arms, and two of the pouches rest against the back, over the shoulder blades, the others, one on either side of the breast. Both ends of the tube are inclosed in small metallic cylinders, each of which contains a charge of carbide of calcium. The belt is invisible and can be worn by a passenger during an entire voyage without inconvenience and without being noticed by the other passengers. According to the experiment at La Rochelle, a man wearing a Gros life belt fell overboard and sank. He immediately arose to the surface and continued to float, head and shoulders out of the water and both arms in the air. It was estimated that only two seconds elapsed from the instant the water touched the carbide until the sacs or pouches were filled with sufficient gas to keep the man afloat.

A writer in the *Electrical Review* (London) says that one of the most important properties of mica and one on which its value largely depends in electrical manufacture, is its remarkable property of lamination, its structure in this respect being so perfect that it is possible to divide it by cleavage into leaves or sheets 0.000004 inch thick, or one two-hundred-and-fiftieth of the thickness of tissue paper. In consequence of its superior insulating property, and also the very great advance made in electrical industries, the demand for mica at the present day in almost every country is so great that the supply is almost inadequate. It is not only the superior insulating property of the mineral that gives it such an advantage, but its characteristic and peculiar structure which makes it so adaptable as an insulator requiring very little machining or shaping. For instance, it is a substance which could not be well replaced as an insulator of commutator segments, for it is not only the best but an efficient insulator under every condition. In the case of the commutator its hardness makes it invaluable, for it wears away under the friction of the brushes nearly at the same rate as the hard-drawn copper of the commutator itself. Further, the fact that heat does not alter its structure or insulating property makes it most invaluable to the electrician.

The *Locomotive* describes an explosion of a hot water boiler in a prominent club house in Hartford, Conn., which did damage to the extent of about $2,500. Fortunately, no one received severe bodily injuries, although a number were violently shaken. The boiler was supposed to be perfectly safe, as it was normally subjected to pressure of the city mains only, which is about 65 pounds. But it developed that a check valve had been put in the supply pipe between the boiler and the street to prevent hot water backing into the mains, as would occur when the kitchen fire was hard pushed and little or no hot water was used. The objection to having the hot water enter the mains was that it deteriorated the meter. The check valve stopped the hot water backing up all right, but it did the trick a little too well, as the disastrous result showed. So long as the passage between the boiler and the street main was unobstructed the pressure could never rise above 65 pounds, but when the water began to flow away from the boiler to the main the check closed and further flow was stopped, causing, of course, a great increase in pressure to be quickly generated, as there was no steam space to compress.

The moral is to put no check valves in the supply pipe of a hot water system, but if it must be done a safety valve on the boiler should by all means be supplied. This accident calls attention to the danger of shutting the street cock of any home system with a hot fire running in the kitchen range.

The origin of petroleum is a profound problem to the geologist, and while several theories have been propounded to account for its existence, none of them appears to be quite satisfactory. They mostly agree, however, that whatever the origin of petroleum, it can now be regarded as a fossil product, the same as coal, and that the supply is limited by the extent of the oil-bearing rocks in the earth and their contents. In view of the probable future extinction of coal and petroleum deposits, these theories being considered, that of Mr. Eugene Coste, as expressed at the February meeting of the American Institute of Mining Engineers, is more optimistic, as holding that the production of petroleum is volcanic, and is going on at all times. Mr. Coste points out that wherever oil-bearing rocks are found there are abundant evidences of volcanic action—not necessarily craters, but ruptures and fissures of the earth's crust. In the Texas oil fields the manifestations of volcanic action take the form of small mounds or hills that have been raised above the general level by great internal pressure. If oil was forced from, say, the Spindle Top wells by hydrostatic pressure, as some believe, water should flow from the bores after the oil has ceased to flow, but such is never the case. Mr. Coste believes that oil and gas are only to be found along the fissures and lines of structural weakness in the earth's crust; he is plotting a map of United States and Canada, showing the probable location of these lines, and therefore of probable oil deposits hitherto unsuspected. The study of the volcanic theory may lead to the discovery of a synthetic method for producing oils.

The *Engineering News* calls attention to the desirability of manufacturers sending copies of their trade literature to great public libraries for filing. The Astor branch of the New York Public Library has already accumulated over 30,000 pieces of trade literature and the director is anxious for all manufacturers to put the library on their mailing lists to receive future issues. It appears that some manufacturers are adverse to putting their catalogues and trade literature on file in libraries, for what reasons it is difficult to understand. "The initial purpose of these trade catalogues is to advise the public of the general or detailed character of the products manufactured and the place where and the price at which these products can be secured. While the manufacturers spread this information among those whom they deem to be possible purchasers, they should remember that this last is an unknown quantity, and much good may result to the dealers from sources unexplored in their personal effort. Another good reason why all manufacturers and dealers should do all that lies in their power to make such a collection as complete as human agency can make it, is the value to themselves of such a collection, intelligently classified and made accessible. It is of great profit to any manufacturer to know just what is being done in similar lines by competitors in business. The ostrich-policy of attempting to keep to himself what some mis-call "trade secrets" is antiquated, and serves no useful purpose in this day of wide publicity. And real and valuable trade secrets are not inserted in catalogues. The fact that these catalogues are generally looked upon as merely serving a passing purpose and are rarely preserved in the manufacturer's own office for any length of time, is an added inducement for sending them to an institution that will preserve them and make them useful to all interested searchers after information."

UNTAXED DENATURIZED ALCOHOL.

The announcement by the Republican leaders of Congress that the question of removing the internal revenue tax from denaturized alcohol for industrial purposes would be taken up at the next session as a subject of unmistakable public policy, has awakened anew the interest of automobile manufacturers and operators in the possibilities of this product as a substitute for gasoline. Frequent letters on the subject are being received by the lawyers representing the committee of manufacturers who are co-operating in the action for an untaxed alcohol for the arts, and it is hoped that an automobile representation may be enlisted with the organization. In addition to the Boutell bill, a measure, which covers some details not specified in the other bill, has been drafted by the Commissioner of Internal Revenue at the request of Chairman Payne, of the Ways and Means Committee. The attorneys for the manufacturers' committee have received word that the English Parliament will be urged to enact a measure that will grant the same exemption from taxation to alcohol as provided by the Boutell bill. According to an estimate by Dr. Wiley, of the United States Department of Agriculture, alcohol suitable for generating power in automobiles could be sold as low as fifteen cents a gallon, if the internal revenue tax were removed. Manufacturers of alcohol believe this estimate too low, but state that the cost of the product for automobile use, under the favorable conditions of a removal of the tax, would be from twenty to twenty-five cents a gallon. With the cost of alcohol for this purpose established on a parity practically with that of gasoline, the advocates of the measure in question are urging the advantages of alcohol over gasoline as a motor fuel. These are summed up as follows: Freedom from danger, absence of disagreeable odors, possibility of using high compression, low initial heat and discharge of exhaust gases at relatively low temperature, less sudden and more prolonged explosion, more reliable ignition and combustion. It is claimed that by hydrating the alcohol a still higher compression can be used, and thus a larger fraction of the heat of combustion converted into useful work.—*Horseless Age.*

MOTOR OMNIBUS VS. STREET RAILWAYS.

A recent report from the United States consul at Edinburgh, Scotland, quotes from an address by Mr. John Stirling, of Granton, which endeavors to make out a strong case for the motor omnibus as opposed to the street car running on rails. The quotation reads as follows:

"There is no doubt that the early tramways served a useful purpose and there was probably a reasonable excuse for the desire to have a smooth surface on which to convey large numbers of the citizens, having regard to the general condition of streets in large towns and cities at that time and for a number of years after. The idea that tramways were a necessity took hold of many minds, but I venture to oppose this idea and to say that they are now no longer a necessity, so far, at any rate, as Scottish cities and large towns are concerned, nor are they now the most satisfactory or economical method of moving the population of great centers from place to place. Tramways, with their huge cars, constitute a perpetual street obstruction. They run on their fixed lines and all other traffic must make way for them. As time goes on, the congestion and attendant street dangers will multiply, unless a remedy be found—and a remedy must be found. Alongside the growth and development of electrical engineering, and especially that department of it relating to locomotion, there has been arising and advancing steadily a new competitor, which promises to become at no great distance a serious rival to the tramways. This is the evolution and perfecting of the motor omnibus. It is possible that those interested in tramways may smile at such a prediction, but I make it in all seriousness; the self-propelled omnibus will be adopted in many places instead of tramways, and will yet displace existing tramways in crowded cities. The mobility of the motor omnibus will be an important factor in its success in traffic. It can be run and maneuvered in a way quite impossible in the case of a tram car. A motor-omnibus service is free from the great disadvantage of a tramway service depending upon its power from a central power station. There is no doubt now that the recent improvement in motor omnibuses has made them a thoroughly commercial proposition, and I believe the time has arrived when something should be done to make this fact more widely known than it is."

While there is a certain element of advantage in the motor omnibus idea, it seems to us that its disadvantages overwhelmingly offset it. The fact that street cars are confined to a track and must proceed in an orderly manner and in sequence, gives them a far greater carrying capacity ordinarily than would be possible if each car was able to proceed independently of the others. Think of the vast confusion and danger in narrow streets if the present street railway traffic was attempted by independent cars. The cost of traction would be far above that on steel rails, and the danger to life and limb is something appalling to even think of.

THE PRINCIPLE OF THE PUMP.

Extract from Paper, "Pumps and Pumping Machinery," read by Mr. G. F. Ahlberg before the December, 1903, Meeting of the Engineers' Society of Western Pennsylvania.

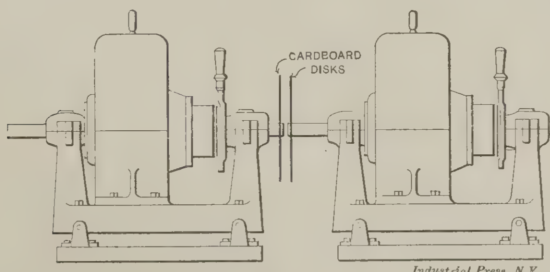
Although the pump was invented about 150 B. C., it was not until the beginning of the seventeenth century that its true principles were understood, it being generally thought to act by means of a force called suction, though no attempt to discover the reason why water rose upward under a piston was made until the time when a pump-maker to a royal duke in Italy complained that the water would not rise higher than 32 feet or thereabouts. Galileo was applied to for a solution, but does not seem to have solved the question. His pupil, Torricelli, considered that the atmospheric pressure might be counterpoise to the 32 feet of water when received into vacuum. The experiment was tried in 1643, and the supposition was found correct and confirmed later by Pascal. From this experiment emanated the discovery of the barometer.

A singular incident happened to a man of Seville who undertook to raise water from a well 60 feet deep by a common pump. Instead of making the sucker play within 30 feet of the water, he made the rod so short that it did not reach within 50 feet of it. As a necessary consequence he could not raise any water. Being greatly disappointed, he descended the well to examine the pipe, while a person above was employed in working the pump, and at last, in a fit of despair, he dashed his hammer violently against the pipe. By this act a small opening was made in the pipe about 10 feet above the water, when the water ascended at the spout. This fact being published in 1776 led to a reinvestigation of the subject, and instead of overthrowing the received doctrine of atmospheric pressure, more fully confirmed it. It was ascertained that the air on entering the pipe became mixed with water, which therefore, instead of being carried up in an unbroken column, was raised in disjointed portions, or in the form of thick rain. The mixture being much lighter than water alone, a longer column of it can be supported by the atmosphere, and by proportioning the air a column of the compound fluid is admitted which may be elevated 100 to 200 feet.

[It is this condition that exists in the so-called Pohle airlift; the compressed air entering the bottom of the well forms a column of air and water that is lighter than the solid column of water outside the lift pipe. Hence the water and air rise to the surface.—EDITOR.]

SIMPLE METHOD OF TESTING ELECTRIC MOTORS FOR SYNCHRONISM.

A correspondent of the *Engineer* (Chicago) tells of a simple method employed by him to determine how nearly two 220-volt, direct-current motors of the same type ran in synchronism. With speed indicators the approximate number of rotations per minute of each motor could be found, but it was desired to discover whether in, say, one minute one armature had turned one-fourth rotation more than the other. To determine this both motors were placed as shown in the sketch, Fig. 1, that is, so that the disks on the ends of the shafts were as close together as possible. The disks were of heavy cardboard and about 16 inches in diameter. In each disk were cut four curved slits about ⅛ inch wide, as shown in Fig. 2.



Industrial Press, N.Y.

Fig. 1.

The motors were connected to the circuit so as to revolve the disks in the same direction. Then by looking at the side of one disk and holding a light back of the other, a ring of light was seen at the points of intersection of the slits. This can be understood by referring to Fig. 3. The ring of light will appear at the intersection of the curved slits at a distance equal to *A B* from the center. In the drawing at the right, one disk has revolved one-eighth revolution, and the points of intersection have moved out to *A′* and consequently the ring of light will appear at the distance *A′ B′* from the center, and a new ring will appear at *C*. These rings will form at the circumference and move toward the center, or they will form at the center and move outward according to which motor is running the faster, but if the ring appears stationary then both armatures must be running at exactly the same speed.

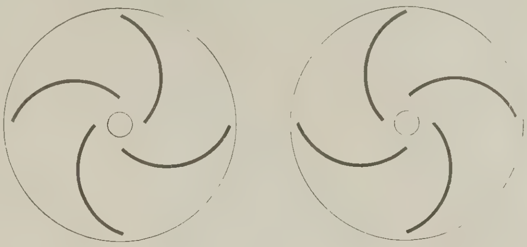
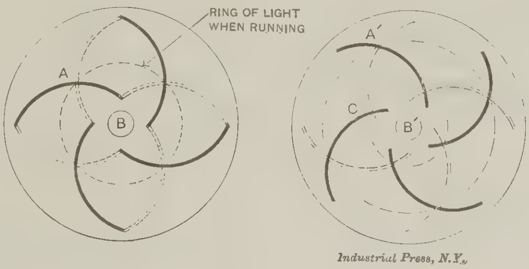

Industrial Press, N.Y.

Fig. 2.

With a slide wire rheostat in the shunt field of one motor, it was possible to cause the ring of light to remain stationary as long as the voltage did not vary. A slight variation in the voltage would cause the ring of light to move one way or the other, on account of the difference in speed of the two motors.



Industrial Press, N.Y.

Fig. 3.

THE ACTION OF RADIANT HEAT.

Electrical Review, April 15, 1904, Page 619.

A novel theory of radiant heat is hinted at by a contemporary, which has, indeed, with a certain consistency, long held forth views in regard to radiant heat that would appear to be somewhat subversive of accepted theories of energy. The view taken is illustrated by the following example, which is put forward as having been actually tried and proved. At least, so we interpret the assertion as to what would happen should the experiment be repeated. This experiment is as follows or on these lines:

Take two pieces of heated iron of equal weight and temperature. Place one of them inside a small water-jacketed box, and the other inside a large jacketed box. When the iron in each case has cooled through, let us say, 1,800 degrees F., or any other range of temperature, more heat will be found to have entered the water surrounding the small than the large box, the reason being that the iron is nearer to the surface to be heated in one box than it is in the other. Yet no heat can have escaped in either case, on the assumption that the box being closed, all heat has been intercepted by the enclosing water boundary, and distance should not have had any effect. Heat rays, as we may still term the radiant emanation which we know as heat, may be represented as lines of force, and temperature is simply a function of the lines of force, many lines in a given area corresponding with high temperature and *vice versa*. Obviously, in a closed box, the surface to be heated is exposed to the higher temperature, as it is nearer the source of heat. But this does not, of course, explain the absolute disappearance of energy in one case and not in another. Experiments which show this disappearance of energy must always be looked on with some suspicion. Were proper corrections made? A large box loses heat by radiation to a much greater extent than one of smaller size, and errors may easily creep in from this cause alone.

If it be proved, however, that with all calculations energy really has disappeared, then it follows that low temperature radiant heat, or that quality of radiation which has few lines of force per square centimeter, has the power of passing through certain substances, such as iron plate or water, more readily than have the more concentrated rays. Water and iron plate are, in fact, diathermanous to radiant heat, possibly in a certain ratio to the surface exposed to it, and thus arises the advantage of small surfaces and contiguity of the hot body to such surfaces.

Another illustration of the claimed phenomenon is, that large locomotive fire boxes have failed where they ought to have been a success, and this is held to be accounted for by the greater distance from the walls of the box of the source of radiation. We are not satisfied that our contemporary has proved its claim. If true, they ought to be capable of clear and unmistakable proof, and there should be means, also, of discovering whether the escaping radiant heat is outside the large box to the extent of the missing quantity. If neither in the box nor in the jacket water, nor escaping in some other guise, then, indeed, would the theory of energy have been shattered like a clay idol. From the tone of our contemporary, two exactly similar boilers, except for the size of the fire box above the fire level, should show different evaporative effects; yet the boiler which produced the least steam would not reject its gases any hotter. The point is important, for we are being asked to believe that a certain portion of the heat of fuel disappears simply by virtue of passing a few additional inches through space. The lay mind is always liable to become confused as between heat and temperature, and probably no better explanation can be given of temperature than that embodied in the idea of concentration of lines of force.

The common lens or burning glass, which collects what appears to us as but the genial and pleasant warmth of the too infrequent sun, will focus these rays to a point of heat intensity that will fuse the most intractable of substances. Yet beyond the focal point the same original rays will reappear with no such intensity. Temperature is then clearly a concentration effect, and it is very difficult to believe that want of concentration has altered the properties of radiant rays. Something certain, with positive proof, is demanded; mere vague claims and statements unsupported by experimental proof cannot be accepted.

DILATATION OF IRON AND STEEL AT HIGH TEMPERATURES.

Communication presented to the Academie des Sciences by Prof. H. Le Chatelier, and translated from the French by Charles A. Brassler.

The dilatation of steel at elevated temperatures has not been studied very carefully except by Prof. Svedelius, of the University of Upsala; but in the experiments of this scientist the variations of temperature have been so rapid that some doubts may exist on the exactness of the numbers obtained. I have taken up the study of the subject with the collaboration of M. Chartepic, chemical *preparateur* in the School of Mines. We have made use of the method of measuring employed by M. Coupeau in his researches on the dilatation of ceramic pastes. A mirror of cast silicon is inclined more or less, according to the difference of dilatation, between a support of Sèvres porcelain and the body studied; it reflects a luminous ray, of which the angular displacement is measured.

In the dilatation of iron and steel three periods must be distinguished; the first corresponds to temperatures lower than that at the beginning of the molecular transformations; the last to temperatures higher than the close of these transformations; between the two is the period of these transformations.

Dilatation at Low Temperatures.—The iron which I have used is a casting of the following composition: C. 0.057; Mn 0.13; Si 0.05. The following table is deduced from the average curve in a great number of experiments. The dilatations are expressed by taking one-hundredth of the initial length of the rod, that is to say, a millimeter for a rod of 100 millimeters. The last line of the table gives the true coefficient of dilatation for each interval of temperature of 100 degrees C.

Temperature, deg...	0	100	200	300	400	500	600	700	800
Dilatation		0.11	0.23	0.36	0.50	0.65	0.81	0.975	1.125

The tests made with steels properly so called, that is to say, a metal richer in carbon, give numbers essentially the same. The composition of the steels studied is here given:

	1	2	3	4	5	6
Carbon	0.205	0.49	0.84	1.21	0.80	0.75
Manganese	0.15	0.24	0.24	0.24	0.15	0.15
Silicon	0.08	0.05	0.14	0.14	0.06	0.06

The dilatations are added to those given for iron:

Temperature, deg.......	0	100	200	300	400	500	600	700
Soft iron		0.11	0.23	0.36	0.50	0.65	0.81	0.975
Steels 1, 2, 3, 5, 6......		0.11	0.22	0.35	0.495	0.64	0.81	0.975
Steel 4		0.105	0.22	0.35	0.50	0.64	0.80	0.96

The differences between the dilatations of these different metals do not exceed 0.01 millimeter, which corresponds to the limit of precision of the experiments. It may therefore be stated that irons and steels have essentially identical coefficients of dilatation, in the neighborhood of 0.000011 at the ordinary temperature, and increasing regularly up to 758 degrees C., where the true coefficient is 0.000017. The average coefficient between 0 degree and 750 degrees is therefore 0.000014.

This close identity of the coefficients of dilatation is explained by what is known of the constitution of steel. It consists of a preponderating mass of pure iron, in which are distributed a small quantity of crystals of the carbide Fe^3C. At least four-fifths of the iron is in an uncombined state; it is therefore natural that steel should preserve nearly the dilatation of the pure metal.

Dilatation at Elevated Temperatures.—Above temperatures of molecular transformation, the dilatation of different steels varies very rapidly with their percentage in carbon.

This result agrees perfectly with the facts we possess in regard to the constitution of steel. Above the molecular change ferric carbide and iron constitute together a solid solution; in similar cases, as I have previously shown, the dilatation has not necessarily any relation with those of the constituents; it may be much higher than theirs.

Period of Transformation.—It has been impossible for me to realize molecular transformations under strictly reversible conditions; on this point, my experiments are no more satisfactory than those of Prof. Svedelius. I present the results as only provisional, intending to return to this subject in the future.

Percentage of carbon	0.05	0.20	0.5	0.8	1.21
Average temp. of transf., deg...	840	768	728	730	725
Extent of contraction	0.26 mm.	0.23 mm.	0.21 mm.	0.08 mm.	0.10 mm.

The contraction is expressed in millimeter fractions and applied to a length of 100 millimeters.

These contractions are very irregular from one experiment to another, and are often followed by dilatations which compensate them partially. A large number of these anomalies might be explained by supposing that this change is the result of two successive phenomena; one, the molecular conversion of the iron, which is accompanied with a contraction of 0.26; the other the dissolution of the ferric carbide in this transformed metal, which would be accompanied with a dilatation, the extent of which would be also 0.26 for a percentage of carbon of about 0.9.

THE MANUFACTURE OF PIPE.

Abstract of Paper read by Victor Beutner before the Engineers' Society of Pennsylvania, December 15, 1903.

The earliest method of manufacturing tubes was that employed by gunsmiths from the invention of fire arms until the first quarter of the last century. A piece of flat iron is bent around a mandrel, and the overlapping edges are brought to a welding heat, a few inches at a time, and welded by blows of a hammer. For the hand hammer of the earlier smiths a helve or trip hammer was substituted.

When with the introduction of gas and steam the demand for tubes increased greatly, it became necessary to insist on a greater uniformity than could be obtained in hand welding, and in 1824 James Russel passed the hand welded tubes through a set of rolls and over a mandrel, thereby obtaining the proper inside and outside diameter of the tube. James Russel further established the fact that a sufficiently strong joint can be obtained by forcing the ends of the skelp against each other, instead of overlapping them, as had always been done previously. This fact led directly to the introduction of the new methods of butt welding pipe, which are still in use in practically their original form. James Whitehouse, in 1825, took out a patent covering the following process: A piece of skelp of suitable width is bent until the two edges nearly meet. One-half of this bent skelp is inserted in a furnace and brought to welding heat. The cold end is fastened in a suitable manner to the traveling chain of a draw bench. The two halves of a ring-shaped die are closed together by a pressure screw; the chain is started and the heated portion of the skelp drawn through the die. The diameter of this die is a trifle smaller than the outside diameter of the skelp, and the pressure exerted is sufficient to close the joint of the skelp by welding the edges together. Then the half welded pipe is reversed, and the other end finished in the same way. The pressure screw used to force the two halves of the die together soon proved far too slow and tongs were used, shaped as shown in Fig. 1, the jaws of which formed the dies, and could be quickly opened and closed. The draw bench was provided with a steadying rest against which the tongs were rested while the tube was drawn through.

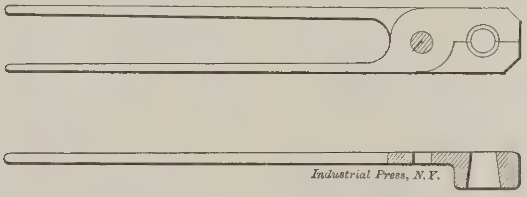


Fig. 1. Tongs for Butt Welding Pipe.

Very soon a most important improvement was made in the manufacture of butt welded pipe. A solid die, usually called a bell, was employed, and it was found possible to bend and weld the skelp in one operation, by first clipping the corners of the skelp, and by employing suitably constructed tongs, which gripped the skelp very firmly, yet were small in diameter and could pass through the opening of the bell, Fig. 2. This method, usually called the bell weld method, has found a very large field, owing to its simplicity and cheapness. The strength of such butt welded joint is also very remarkable. I have seen 1-inch pipe, made by this method, tested to 1,000 pounds per square inch hydrostatic pressure, and the thickness of metal of 1-inch standard pipe is little more than 1/8 inch. The limitations of the bell weld methods are self-evident. When either a very great resistance to inside pressure is required, or when it is essential to keep the thickness of metal down, it is impracticable. The skelp of large pipes has the tendency to collapse, instead of filling the bell, and although I have seen 4-inch pipe made successfully, the usual commercial limit for this process is 2 inches, or, at most, 2½ inches. The smaller sizes, say below 3/8 inch, present another obstacle, since the gripping tongs must pass through an opening of the bell, which is too small to allow of their proper strength of construction. In this case, the tong process described above is employed, while in all the other cases the lap weld method must be resorted to.

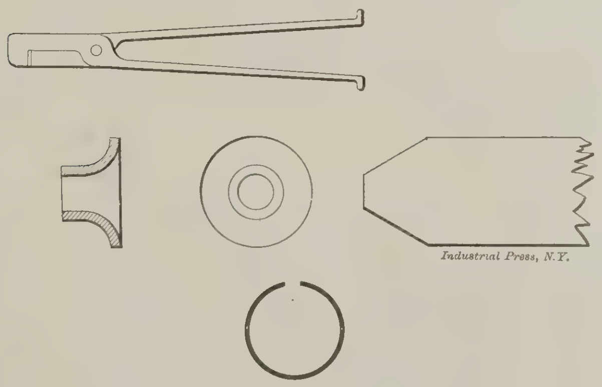


Fig. 2. Butt Welding with the Bell.

This method dates back in all its essential features to about 1840, when it appears that both the Russels and a man named Martin Jones took out patents covering it. In this method the skelp, previously bent in a manner that one edge overlaps the other, is heated to a welding heat, and immediately passed through the grooves of rolls and over a mandrel. Through the pressure between the upper roll and mandrel, usually called ball, the two overlapping edges are united, as in Fig. 3.

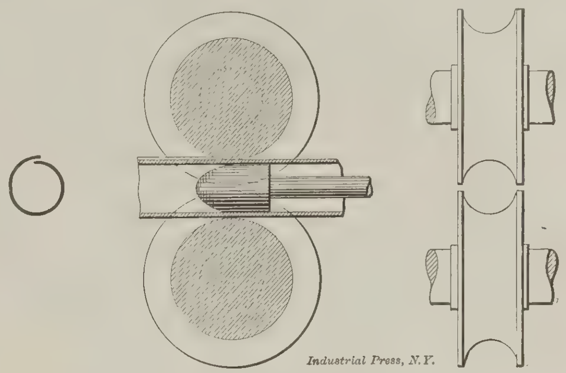


Fig. 3. Lap Welding Pipe.

Although not altogether within the scope of this talk, it might prove interesting to have the most important method of manufacturing seamless tubes discussed briefly. The oldest and simplest method is the rolling or drawing out of a billet, which has been previously pierced by forcing a punch through its center while in a red-hot state. Another method is illustrated by Fig. 4. Through a number of successive operations a flat sheet of metal is cupped, the depth of this cup increasing with each operation. Lastly the bottom is cut off, and, if desired, the tube may be finished by drawing. A patent taken out some fifteen years ago provides for the casting of small ingots with a core of powdered refractory material, which hollow ingot is again finished as above.

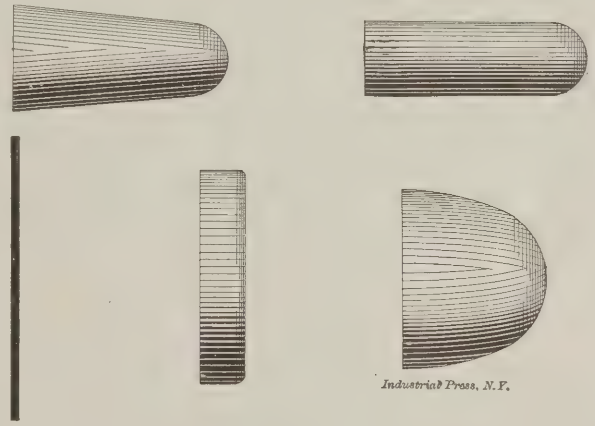


Fig. 4. Forming Seamless Pipe by Drawing.

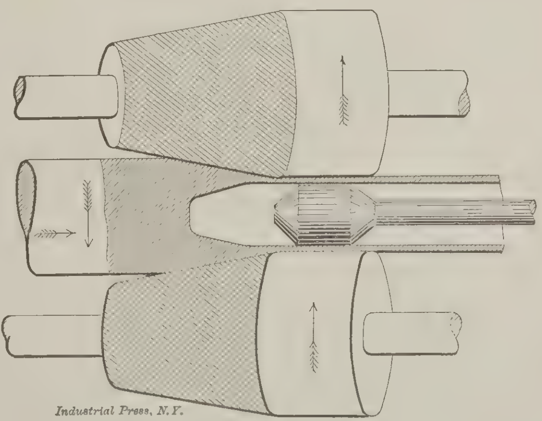


Fig. 5. Mannesman Process of making Seamless Tubing.

Quite a startling innovation, however, was embodied in the principle of diagonal rolling, as covered by a number of patents awarded to the brothers Mannesman in 1885 and 1886. This principle can be carried out in a number of ways, of which Fig. 5 and Fig. 6 are representative instances. It can be readily seen from the sketches that the rolls impart a rotary or whirling and a forward motion to the piece. In the arrangement shown in Fig. 5 this forward motion is caused by the inclination of the axes of the conical rolls in relation to each other, while in Fig. 6 the rolled piece is introduced not quite on line with the axes of the mushroom rolls. An altogether satisfactory explanation for the remarkable results of this method is hard to give. It seems that the material instead of flowing in a longitudinal direction, as in the ordinary rolling, has a tendency to flow outward toward its circumference, owing to the rotary motion, a distinct displacement of the fiber taking place. This fact is shown clearly in Fig. 6, where the resulting tube has a larger diameter than the original billet. The mandrel shown in both cases has nothing to do with the formation of the hole, and only serves to smooth the inside of the tubes.

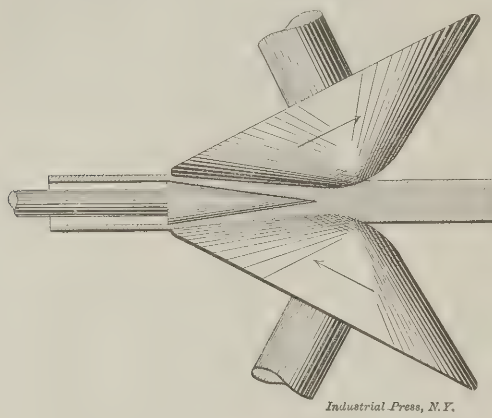

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Fig. 6. Another Form of the Mannesman Process.

In the Stiefel process, patented in 1895 and shown in Fig. 7, a heated billet is passed between the faces of two parallel disks, which impart to it a rotary and a forward motion, forcing it thereby against and over a piercing mandrel. The working faces are shaped in such a manner as to cause a uniform speed of rotation, and thus the parallel longitudinal arrangement of the fibers is not disturbed.

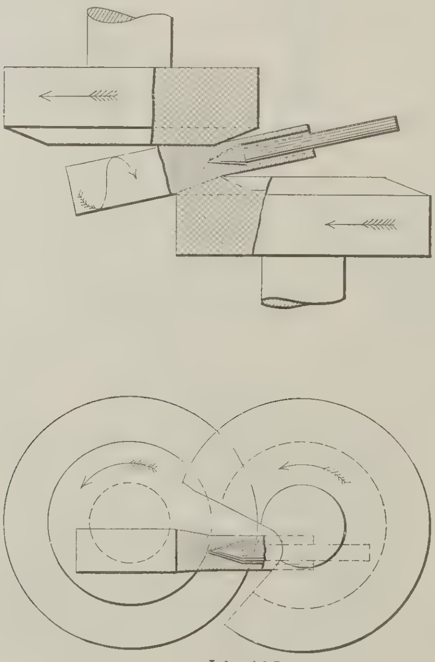
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Fig. 7. Stiefel Process.

In the Ehrhardt process a piercing bar is forced into a solid billet, the cross section of which corresponds with the area of the tube to be produced. This billet, heated to white heat, is placed in a form, which corresponds to the outer shape of the tube. The difference of the area of this form and of the area of the billet must be equal to the area of the piercing bar. The metal forced from its center flows to the outside, taking up the space between the original billet and the form, which is equal to the amount of material displaced by the piercing bar.

As to the comparative merits of the seamless drawn and the ordinary welded pipe, the first certainly presents a highly interesting subject from a technical standpoint, and through the ample discussion of the various methods in scientific bodies and the advertising derived from its use for boilers, or other tubular appliances, the seamless tube has gained quite a notoriety, but of all the wrought pipe manufactured to-day, 95 per cent., and probably even considerably more, is made by either the butt or lap weld method. The great difference in the cost of manufacture and the fact that although seamless pipe might be better, the ordinary welded pipe is amply good enough for all but exceptional cases, are the obvious reasons for this fact.

COST OF MILL BUILDINGS.

Proceedings of the New England Cotton Manufacturers' Association.

The accompanying diagrams and explanation of same were presented by Mr. Chas. T. Main, the mill engineer, at the April meeting of the N. E. Cotton Manufacturers' Association. The mill type of construction is so well adapted for machine shops, when the product consists of small machinery or parts of machines, and especially where land is valuable, as in cities, that we think the diagrams will be appreciated by readers of MACHINERY who are interested in shop building, or in the appraisal of shop property.

It is not an uncommon thing to hear the cost of mill buildings placed from 60 to 80 cents per square foot of floor space, regardless of the size or number of stories. There is, however, a wide range of cost per square foot of floor space, depending upon the width, length, height of stories and number of stories.

We recently placed a valuation upon a portion of the property of a corporation, including some 400 or 500 buildings. In order to have a standard of cost from which to start in each case, we prepared a series of diagrams showing the approximate costs of buildings varying in length and width, and from one story to six stories in height. The height of stories also was varied for different widths, being assumed 13 feet high if 25 feet wide, 14 feet if 50 feet wide, 15 feet for 75 feet, 16 feet for 100 feet and over.

The costs used in making up the diagrams are based largely upon the actual cost of work done under average conditions of cost of materials and labor, and with average soil for foundations.

The costs given include plumbing, but no heating or sprinklers.

Use of Diagrams.

1. The diagrams can be used to determine the probable approximate cost of proposed brick buildings to be used for manufacturing purposes, and these can be taken from the diagrams readily. For example, if it is desired to know the probable cost of a building, 400 feet long by 100 feet wide by 3 stories high, refer to the sheet showing the cost of three story buildings. On the curve for buildings 100 feet wide, find the point where the vertical line of 400 feet in length cuts the curve, then move horizontally along this line to the left hand vertical line, on which will be found the cost of 66 cents. For present prices of materials and labor, add about 5 per cent., making the total about 70 cents per square foot.

The cost given is for brick manufacturing buildings under average conditions, and can be modified if necessary for the following conditions.

a. If the soil is poor or the conditions of the site are such as to require more than the ordinary amount of foundations, the cost will be increased.

b. If the end or a side of the building is formed by another building, the cost of one or the other will be reduced.

c. If the building is to be used for ordinary storage purposes with low stories and no top floors, the cost will be decreased about 10 per cent. for large low buildings to 25 per cent. for small high ones, about 20 per cent. usually being fair.

d. If the buildings are to be used for manufacturing purposes and are to be substantially built of wood, the cost will be decreased about 6 per cent. for large one story buildings to 33 per cent. for high small buildings, and 15 per cent. would usually be fair.

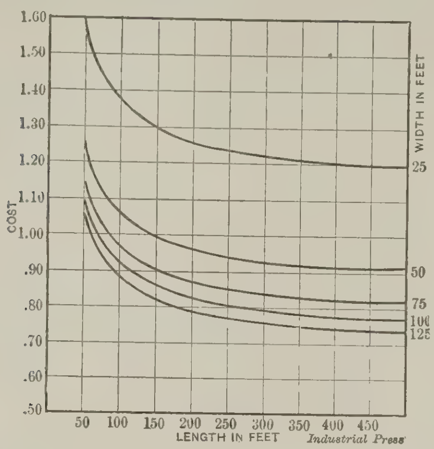

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Fig. 1. Diagram showing Estimated Cost of Manufacturing Brick Buildings, one Story High, per Square Foot of Gross Floor Space.

e. If the buildings are to be used for storage with low stories and built substantially of wood, the cost will be decreased from 13 per cent. for large one-story buildings to 50 per cent. for small high buildings, and 30 per cent. would usually be fair.

f. For office buildings the cost must be increased according to the finish.

The cost of very light wooden structures is much less than the above figures would give.

Basis of Estimates.

The following table shows the costs which form the basis of the estimates, and these unit prices can be used to compute the cost of any building not covered by the diagrams.

PRICES AND OTHER DATA USED FOR ESTIMATING THE COST OF BRICK BUILDINGS.

	FOUNDATIONS, including excavations. Cost per lin. ft.		BRICK WALLS. Cost per sq. ft. of surface.		Columns including Piers and Castings.
	For Outside Walls.	For Inside Walls.	Outside Walls.	Inside Walls.	Cost of one.
One Story Building.	1.75	1.50	.33	.40	12.00
Two " "	2.50	2.00	.37	.40	12.00
Three " "	3.25	2.50	.40	.40	12.00
Four " "	4.00	3.00	.43	.40	12.00
Five " "	4.80	3.50	.46	.40	12.00
Six " "	5.80	4.00	.50	.40	12.00

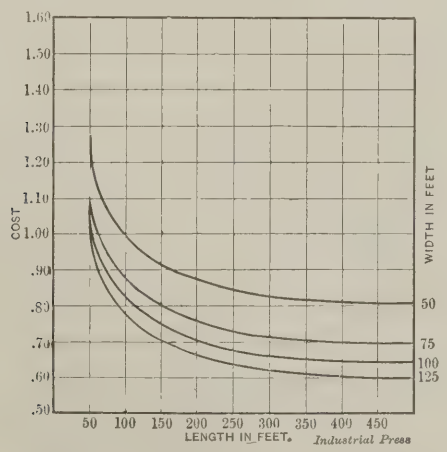

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Fig. 2. Same as Fig. 1, but for Three Stories.

Assumed Height of Stories.

From ground to first floot, 3 feet.
Buildings, 25 feet wide; stories, 13 feet high.
Buildings, 50 feet wide; stories, 14 feet high.
Buildings, 75 feet wide; stories, 15 feet high.
Buildings, 100 feet wide; stories, 16 feet high.
Buildings, 125 feet wide; stories, 16 feet high.

Floors, 25 cents per square foot of gross floor space.

Roof, 20 cents per square foot. Roof to project 18 inches all around buildings.

Stairways, including partitions, $100 each flight.

Allow 1 stairway and one elevator tower for buildings up to 150 feet long.

Allow 2 stairways and one elevator tower for buildings up to 300 feet long.

Allow 3 stairways and one elevator tower for buildings over 300 feet long.

Plumbing, $75 for each fixture including piping and partitions.

Allow 2 fixtures on each floor up to 5,000 square feet of floor space and add 1 fixture for each additional 5,000 square feet of floor or fraction thereof.

The cost of brick walls is based on 22 bricks per cubic foot, costing $15.00 per thousand laid. Openings are estimated at 33 cents per square foot, including windows, doors and sills.

Ordinary mill floors, including timbers, planking and top floor, with Southern pine timber at $30.00 per thousand foot board measure and spruce planking at $20.00 per thousand, cost about 25 cents per square foot, which has been used as a unit price.

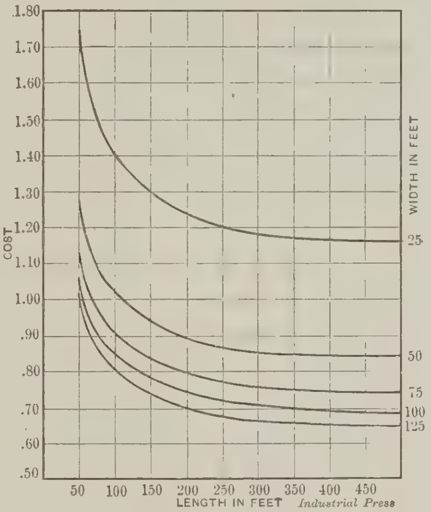

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Fig. 3. Same as Fig. 1, but for Six Stories.

Ordinary mill roofs covered with tar and gravel, with lumber at the above prices, cost about 20 cents per square foot, and this has been used in the estimates.

Add to above for stairways, elevator wells, plumbing, partitions and special work.

The present prices for materials and labor would increase the cost as shown on the diagrams about 5 per cent.

Deductions from Diagrams.

1. An examination of the diagrams shows immediately the decrease in cost as the width is increased. This is due to the fact that the cost of the walls and outside foundations, which is an important item of cost, relative to the total cost, is decreased as the width increases.

For example, supposing a three-story building is desired with 30,000 square feet on each floor.

If the building were 600 feet by 50 feet, its cost would be about 80 cents a square foot.

If the building were 400 feet by 75 feet, its cost would be about 71 cents a square foot.

If the building were 300 feet by 100 feet its cost would be about 68 cents a square foot.

If the building were 240 feet by 125 feet, its cost would be about 66 cents a square foot.

2. The diagrams show that the minimum cost per square foot is reached with a four-story building. A three-story building costs a trifle more than a four-story. A one-story building is the most expensive. This is due to a combination of several features.

a. The cost of ordinary foundations does not increase in proportion to the number of stories, and therefore their cost is less per square foot as the number of stories is increased, at least, up to the limit of the diagrams.

b. The roof is the same for a one-story building as for one of any other number of stories, and therefore its cost relative to the total cost grows less as the number of stories increases.

c. The cost of columns, including the supporting piers and castings, does not vary much per story as the stories are added.

d. As the number of stories increase, the cost of the walls, owing to increased thickness, increases in a greater ratio than the number of stories, and this item is the one which in the four-story building offsets the saving in foundations and roof.

3. The saving by the use of frame construction for walls instead of brick is not as great as many persons think. The only saving is in somewhat lighter foundations and in the outside surfaces of the building. The floor, columns and roof must be the same strength and construction in any case.

CONCERNING THERMOMETERS.

The Locomotive, December, 1903, Page 191.

Thermometers of all grades may be bought in the market, ranging from those that are suitable for decorative purposes and whist favors to those that are used for accurate scientific purposes. In the present article we shall speak only of "ordinary" thermometers, such as may be bought for from twenty-five to fifty cents, and which serve as the bases of the familiar controversies that arise in unusually cold or hot weather, among amateur meteorological observers.

A thermometer consists of four distinct parts—the stem, the bulb, the enclosed mercury (or other fluid), and the scale on which the degrees are marked. In the manufacture of the stem a quantity of glass about the size of a peach pit is taken upon the end of a glass worker's blowpipe, and blown up until it is about 2½ inches in diameter and elliptical in form. This is dipped again into the glass crucible, so that it gathers more glass, and the blowing continues. After a time another workman attaches his blowpipe to the bottom of the mass, and the two men, both blowing, move away from each other so as to draw the bulb out into a long, fine tube, which is frequently as much as three hundred feet in length. The capillary tube thus prepared is cut into lengths, and reheated in an annealing oven, so that it may be straightened and also relieved of the internal stresses due to its original cooling. When a considerable number of lengths have been accumulated in this way, the diameter of the bore is measured in each specimen by the aid of a microscope, and the tubes are sorted out accordingly.

In the manufacture of a thermometer, a piece of this capillary tubing of the proper length is first selected, and to one end of this a piece of semi-molten glass of a special kind is attached, air being then forced through the capillary tube until the glass so attached is blown out into a bulb of the proper size. While the bulb is still hot, and the air in it is therefore rarefied by expansion, the open end of the stem is dipped into mercury, and as the heated glass cools the mercury is drawn up through the stem until it partially fills the bulb. The bulb is then heated again, and the operation is repeated until both the bulb and stem are completely filled. The bulb is then heated to a temperature a few degrees above the highest temperature which the thermometer is intended to measure, and when the mercury ceases to overflow at the open end the capillary tube is sealed in the flame of a blowpipe. The glass and mercury parts of the instrument are then complete, and it remains to attach a suitable scale.

The ideal way to graduate a thermometer scale is as follows: The thermometer is first placed in the steam arising from water that is boiling freely under normal atmospheric pressure, and the point to which the mercury rises is marked (for a Fahrenheit thermometer) "212 degrees." The instrument is then placed in a mixture of water and pulverized ice, and the point to which the mercury sinks is marked "32 degrees." The space between these two marks is then divided into 180 equal divisions, which are called degrees. If the thermometer is not intended to measure such a wide range of temperature, the same idea can be carried out by comparing the instrument, at any two convenient temperatures whatsoever, with a standard instrument which has been previously graduated in the manner described.

LOCOMOTIVE TESTING PLANT AT THE LOUISIANA PURCHASE EXPOSITION.

Bulletin No. 2, issued by the Pennsylvania Railroad Company.

The Pennsylvania Railroad System has been assigned a space in the Transportation Building of the Louisiana Purchase Exposition, three hundred feet in length and ninety feet in width, a portion of which will be devoted to a locomotive testing plant. Located in the second bay from the south side of the building and facing one of the wide entrances of its western exposure, this space is easily accessible for the locomotives which will be tested. The general arrangement of the plant is shown in Figs. 1, 2 and 3, in end elevation, side elevation and in plan. The letters designating the essential parts are the same on each cut.

The locomotive under test is carried on supporting wheels whose axles are extended to receive absorption brakes. The turning of the driving wheels causes the supporting wheels to revolve, but these are retarded by the brakes to any extent desired. The work actually done by the locomotive consists in overcoming the frictional resistance of the supporting wheels and brakes, the resulting force exerted at the drawbar being measured by a traction dynamometer. The upper faces of the supporting wheels *J* are at the level of the tracks and of the floor of the building, with a pit of sufficient depth for these wheels and their supports. The base of the plant consists of two longitudinal bed plates, *A*, of cast iron, secured to concrete foundations of ample depth for the weight to be carried, and to resist the shocks transmitted from the locomotive driving wheels when revolving at high velocities. The bed plates are provided with T-slots running longitudinally, and by means of suitable bolts the pedestals *B* are secured to them, thus permitting adjustment lengthwise, in order that the supporting wheels may be located to correspond with the spacing of the driving wheels of the locomotive to be tested.

There will be two sets of supporting wheels, one consisting of three pairs, 72 inches in diameter, for use under passenger types of locomotives having large driving wheels, and one set of five pairs, 50 inches in diameter, to be used under locomotives with smaller wheels and designed for freight service. The pedestals will be of two heights; the lower ones for the supporting wheels of larger diameter, the higher ones for the smaller supporting wheels. The journal boxes carried in the pedestals are self-adjusting so as to secure uniform support for the journals. The lower half of the box contains a bronze bearing of suitable composition, while the upper half, which acts only as a cap and carries no weight, is made of cast iron. The bearing surface is ample for the weight to be carried, but in order to provide against any possibility of heating, the journal boxes are cored out and arranged for cooling by water circulation. The lubrication is accomplished by two chains over each journal dipping into a bath of oil. On the ends of each supporting shaft are the absorption brakes *C* which form the resistance which the locomotive must overcome, in order to exert its tractive effort at the drawbar. They are designed on a plan which enables them to work with perfect smoothness, to be used with ease and convenience and to have a large capacity. This type of brake was first used as a dynamometer at the Worcester Polytechnic Institute, and is the invention of Mr. G. I. Alden, formerly a member of the Institute faculty. This brake in its simplest form consists of:

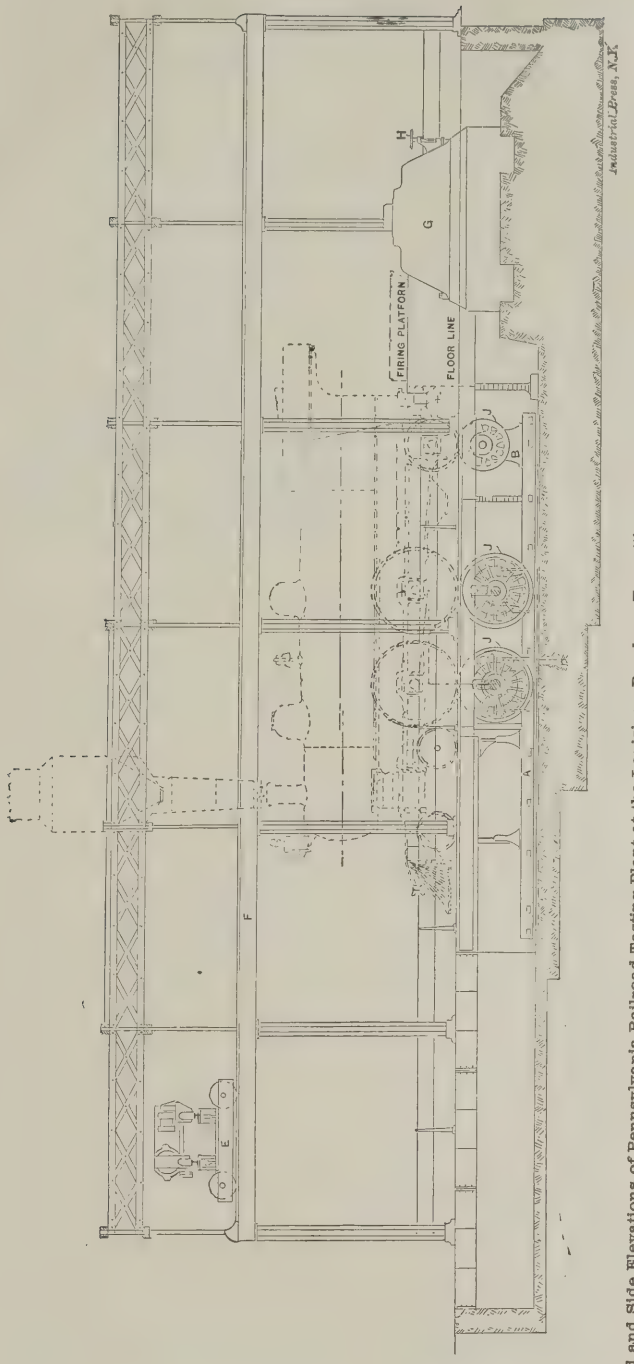
1. A smooth, circular, revolvable cast-iron disk, with radial grooves, keyed to the shaft which transmits the power to be absorbed.

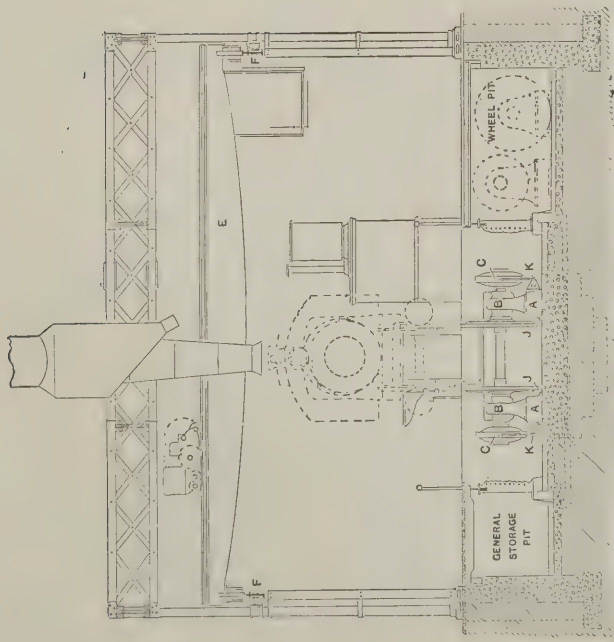
2. A non-revolvable housing having its bearings upon the hub of the revolvable disk.

3. A pair of thin copper plates fastened to the housing, one face of each copper plate being close and parallel to the sides of the revolvable disk, the other face of each plate having back of it a chamber in the housing.

4. A system of piping and connections by means of which water under pressure can be circulated through the chambers between the copper plates and the housing.

5. A system of piping and connections by means of which oil is circulated in such manner as to insure perfect lubrica-





Figs. 1 and 2. End and Side Elevations of Pennsylvania Railroad Testing Plant at the Louisiana Purchase Exposition.

tion of the copper plates which are next to the revolvable cast iron disk.

To insure sufficient capacity, each brake is provided with two disks revolving inside of each housing with a suitable arrangement of copper plates and water chambers, to allow pressure to be exerted on both sides of each disk. Oil for lubrication between the revolving surfaces, enters near the hub of the disks and is carried by centrifugal force along the radial grooves in their sides and out to their peripheries, completing the circuit through external tubes. The housings of the brakes are secured against turning by rods attached to brackets *K*, which in turn are held to the sides of the bed plates by bolts in T-slots. The seats on the supporting shafts for the hubs of the brake disks are tapered, as at *D*, keys being placed in the shaft and hub to prevent turning. Nuts on the smaller end hold the hubs in position. Eight absorption brakes are provided, and may be used either on the shafts having the 72-inch supporting wheels, or on the shafts with the 50-inch supporting wheels, means for removing the brakes readily being provided by the taper fit already mentioned and a nut at the large end of the taper, so that the hub of the brake can be backed off without difficulty or delay.

When the brakes are in use, water under pressure flows through the chambers in the housings, pressing the copper plates against the sides of the revolving disks and causing resistance to their rotation. The pressure of the water is regulated by valves controlling both the inlet and outlet independently. The water thus performs the double function of supplying by its pressure the required friction, and by its rate of flow means of carrying off the heat generated. The pipes leading to and discharging from the brakes are brought together at one point where all the valves will be located, so that the pressure and rate of flow, can be readily adjusted to the work being done. To keep the speed of the locomotive constant, would ordinarily require hand manipulation of the valves controlling the ingoing and outflowing water, but in order to secure as nearly as possible constant speed, there is a by-pass around the main valve controlling the supply of water for all the brakes, and in this by-pass is an automatic valve controlled by the speed of the locomotive. If the speed increases beyond the desired number of revolutions per minute, the by-pass valve opens, so as to increase the pressure on the brakes, and if on the other hand, the speed of the locomotive falls below that desired, the automatic valve closes, and decreases the pressure on the brakes.

The supporting wheels resemble in form the usual locomotive driving wheels, having cast steel centers with tires shrunk on, and held in addition by retaining rings. The contour of the tire is approximately that of the head of a rail, but provided with means of keeping away from its bearing surface the oil which will necessarily drip from the locomotive while running.

The pit containing the parts already mentioned, is extended sufficiently to provide room for the storage of the supporting wheels, axles, brakes and pedestals which are not in use, and provides storage for such other supplies and appliances as will be necessary for the operation of the plant. The floor covering this portion of the pit is made in sections, so that it can be removed as occasion may require. The central portion of the pit, however, will be entirely open with the exception of sufficient platform to enable those taking part in the tests to secure indicator cards, make observations of temperatures and obtain other information of this character.

A traveling electric crane, *E*, of 10 tons capacity, and having a span of 43 feet between centers of runways *F*, serves the entire space occupied by the testing plant, also sufficient space beyond the pilot of the longest locomotive to be tested, to reach the cars loaded with supplies for the plant. The crane will be used for handling the supporting wheels, axles, brakes, pedestals and other parts, when necessary to change their setting, and further, for handling all of the coal used during the tests.

The water required for locomotives under test will be weighed in two tanks, filled alternately and run from these into a third tank, from which it will be taken by piping to the connections for the injectors. As a check on the weights thus obtained, the whole supply used will be metered and readings taken at such intervals as will enable the amount shown by weighing to be compared.

The traction dynamometer *G* which measures the drawbar pull of the locomotive is of the lever type and is constructed on the "Emery" principle, in which flexible steel plates take the place of knife edges used in ordinary scales. The weight of each lever is taken by a vertical plate in a plane intersecting that of the receiving fulcrum plates at their center of rotation, thus relieving these plates of all transverse load. The yoke embracing the dynamometer and to which the drawbar is attached, is also mounted on flexible plates and braced by long and flexible rods, to insure frictionless motion in the horizontal plane only. The total motion of this yoke and drawbar, due to the leverage of the machine and to stress of parts when under full load, does not exceed four one-hundredths of an inch, so that a locomotive exerting a drawbar pull equal to the full capacity of the dynamometer, will not move forward on the supporting wheels more than the amount specified. The drawbar is provided with a ball joint, to allow for any side motion of the locomotive, or motion of the locomotive on its springs.

Near the base of the dynamometer the oscillating motion of the ends of the last levers is transformed into a rotary motion by means of steel belts wrapped around a drum and kept in constant tension by suitable clamping devices. The belt drum is mounted on a tube guided in ball bearings, and inside of it is a rod, the upper part of which is securely fastened to the tube, the lower end being firmly attached to the frame of the machine. It will thus be seen that when the belt drum is rotated, the rod inside of the tube is in torsion, and this resistance forms part of the total resistance of the machine, and is a constant for the same travel of the recording pen. To the upper end of the tube already mentioned are secured two radial arms, the extreme ends of which are finished to a circle having its center at the center of the tube. The angular motion at the end of one arm imparts straight line motion to a carriage, guided by a grooved track and carrying the recording pen. The opposite arm is coupled by steel belts to a rotary oil dash pot, to reduce violent oscillations of the recording pen, the extent of which can be controlled as desired. The principal resistances in the dynamometer are flat springs, placed under the second levers and deflected by the motion of these levers. There are three sets of these springs, varying in resistance so that a travel of eight inches of the recording pen corresponds to a drawbar pull of either 80,000 pounds, 40,000 pounds or 16,000 pounds, as may be desired. The drawbar pull is traced upon a strip of paper 18 inches wide, made to travel at a known rate for each mile run by the locomotive, and this will form the permanent record of the drawbar pull in each test. The yoke and drawbar of the dynamometer can be adjusted vertically through a range of 12 inches by means of a wheel *H*, in order that the different heights of locomotive drawbars can be accommodated.

The smoke from the locomotive will be carried out of the building by a stack, which can be moved longitudinally of the plant to any position required, and the lower portion of which will be made telescopic, so that it can be raised and lowered for adjustment, and permit the passage of the electric crane, when necessary. The stack has deflectors, so that the sparks discharged by the locomotive can be caught, weighed and form a part of the data obtained.

The instruments necessary to get full information for the tests, will consist, in addition to the dynamometer, of steam engine indicators, gages for steam pressures, draft gages for smokebox, firebox and ash pan, thermometers for temperatures in the smokebox, calorimeters for getting the quality of the steam, a revolution counter and a tachometer for showing the speed in revolutions per minute.

Means for bringing the locomotive safely to its position on the plant form a most important part of the installation. The supporting wheels having been placed in position corresponding to the spacing of the drivers, I-beams resting on the supporting shafts and extending the full length of the pit, will be bolted securely to the inside faces of the supporting wheels. Supports at the ends of the pit and at as many intermediate points as may be necessary will be provided. On the upper flange of the I-beams is riveted a grooved rail, so located that the flanges of the driving wheels will run in this groove; in other words, the locomotive will be moved to its position on the plant by being run on the flanges of its driving wheels, leaving the treads free to come into position upon the supporting wheels. When in place, the special rails and I-beams will be disconnected from the supporting wheels and removed, so as not to interfere with the operation of the plant. Provision will also be made for taking care of the driving wheels without flanges, which will be run over the same grooved rails, the grooves being filled by a suitable section of rolled steel.

A director of tests will be in direct charge of the plant, and of all the tests made. Under him will be an assistant and a foreman, who will give his attention to the machinery, care of the instruments and other necessary work of this character. There will be a large staff of observers for the coal and water used, for taking indicator cards, temperatures and readings from all the instruments forming the equipment of the plant. In order that all of the data obtained may be worked up promptly, computers will be employed, so that the data coming from the observers on suitable blanks, will be tabulated and final results for comparison completed for each test, before similar data for the next run comes to the computing room. A force of 25 men will be constantly employed. All apparatus has been carefully selected and the most approved methods will be used to insure accuracy. The results will be put in a form convenient for reference.

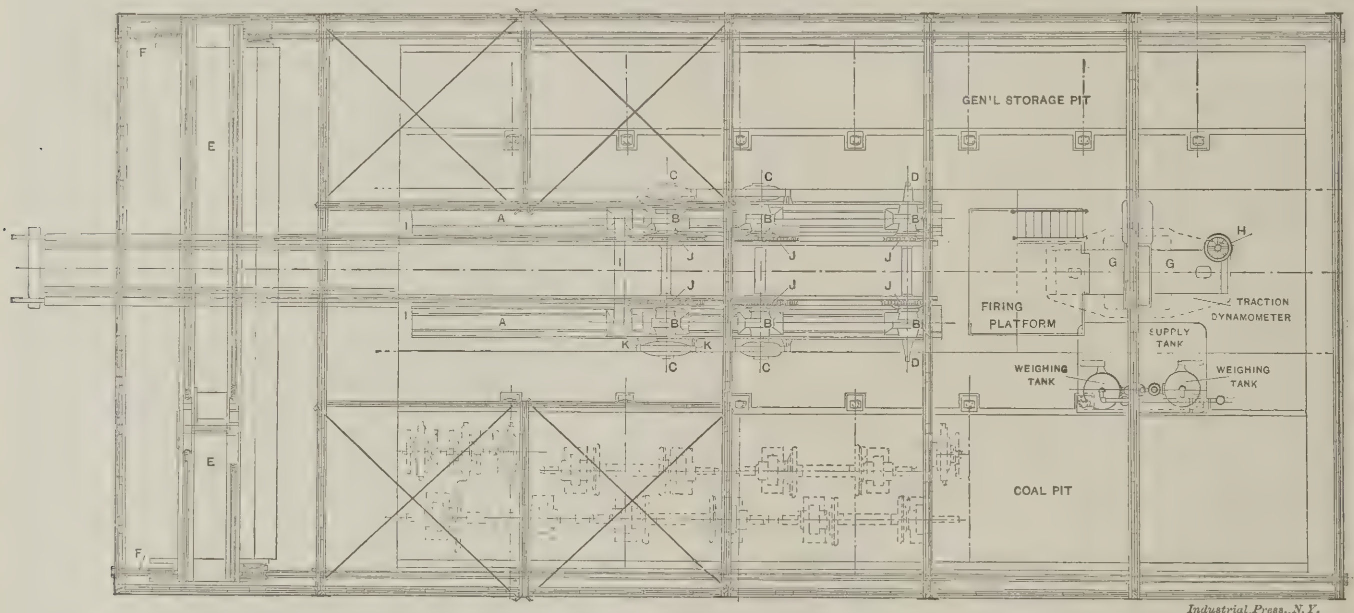


Fig. 3. Plan of Pennsylvania Railroad Testing Plant at the Louisiana Purchase Exposition.

A TALK ON THE DISK GRINDER,

WITH SPECIAL REFERENCE TO TOOL ROOM WORK.

F. N. GARDNER*

F. N. Gardner

In any machine shop or department of a manufacturing plant where tools for manufacturing operations are made, a properly designed and equipped disk grinder should be considered almost indispensable. For a large portion of the operations most commonly done with a file, and many that are considered surface grinder, milling machine or shaper jobs can be done better and quicker, and at less cost for files, cutters, etc., with a disk grinder.

As a simple example: A piece of tool steel is needed, say for a box tool, back rest, a cutter, or a forming tool, to be say, ¼ inch thick, 1 inch wide, 2 inches long, ends and sides straight and square all around. Probably the bar steel ¼ inch x 1 inch will be enough oversize to grind on a disk to exact size, but not enough oversize to work with a milling machine, shaper or surface grinder. Even if larger stock, say 5-16 inch x 1⅛ inch, or a forging, is used, it is only necessary to rough one flat side and one edge down fairly close to size and finish all over on a disk grinder. For squaring ends of one piece like this, and bringing it to exact length, the saving in time over the common way will pay the interest on the first cost of the machine for a month. Suppose this piece has to be hardened, and after hardening must fit a certain space, probably widthwise only, possibly all over. Say one end must be square, the other to have a certain angle. In any case the piece will need truing up and perfecting after it has hardened, and the saving in time will pay at least another month's interest on the cost of the disk grinder.

Referring again to the same piece: How would you square up the ends and bring it to length? You want only one piece. Nick a bar of steel and break it off about 1-16 inch too long. If, as is often the case, you have no milling machine or cutter handy, you get a 12-inch bastard file, spend ten minutes of time, wear out ten cents worth of file, and if you are an expert you have the piece within 1-64 inch to size in the closest place. Now your trouble begins! Fine files, Brown & Sharpe square, caliper gage, etc. If you are an expert filer, on close work, you will get the ends practically straight and square with the sides and edges and your piece to length within, say, .005 inch, in from half an hour to one and one-half hours. If you are not an expert you will never get it that close, because you will spoil it before it is finished. With a disk grinder you will do the job on these ends in about five minutes; you will get the ends square and the length as close as you want it. You do not have to be an expert. All you need is a little practice—not one one-hundredth as much as you would to do the job with a file, but enough to know about how hard to bear to take off .001 inch or .0005 inch, and to judge closely by the feeling and the sparks how fast the wheel is cutting. As a matter of fact, the kind of skill and experience required to do a good job of sizing or fitting with a disk wheel is very similar to that required for doing the same work with a file, but it is acquired a hundred times easier and results are 100 times more satisfactory on any work where a disk wheel can be used, and that means on some portion or all of nearly every piece that has to be put into a vise to file, and on small pieces that are machined on shaper, milling machine or surface grinder.

Hereafter when speaking of the tool room we will mean places where tools are made, not places where tools are kept and checked out to the workmen; in fact, the place where the tool makers work. Nearly every manufacturing plant has such a place.

The equipment of the tool room and the class of men employed in it is a pretty sure indication of the grade and quality of work turned out by the concern. As a rule, tool makers are the most skillful and the highest-priced men employed in a metal-working plant, and it is certainly good business policy to furnish them machinery and tools suitable for getting out their work with the least possible consumption of time. It is safe to state that in the smallest tool room, where only one or two tool makers are employed, a disk grinder will pay a good interest on the investment by the saving of files alone; and many times that in the saving of time.

Many of the operations done in the tool room and machine shop are so common and so simple that no one thinks of installing a new machine to do them. Take, for instance, getting a piece ready to turn in a lathe, say any length up to two feet long, and any size up to two inches diameter. You get the piece cut off either with shears or nicked and broken in blacksmith shop or sawed or cut in the cutting-off machine. In any case, the ends are not square or smooth. You have to center it. If you find the center with a prick punch and dividers, as you probably will if you work in a tool room, you will need a smooth square end to work on, but you will not get it unless you file it square and smooth or catch the piece in a chuck and face the end off with a tool. If the piece has much length you will have to put on your back rest. By the time you have the piece fit for centering and turning, you will have spent from ten minutes to an hour, according to the size and length of the piece. If you have a machine for center drilling and countersinking, this can be done if the ends are not perfectly square, but if you want a good job you will have to square the ends in the lathe, using a side tool. Every good tool maker knows that perfect centers in square ends are the foundation of a good lathe job, but it is so much trouble to make the ends square that many neglect it and that neglect often spoils the job, or the looks of it at least.

How will a disk grinder help you out on such work? You take your piece from the cutting-off machine and grind the ends smooth and square on the swinging table of the disk grinder. If the piece is cut fairly close to the finished length you will grind it to length and square the ends at the same time. It will take from one-half a minute to five minutes, according to the size of the piece and the shape the ends are in. Your ends will then be finished better than you can do them in a lathe and you will not have to touch them again unless you wish to lay the grain circular with a piece of emery cloth.

There are "a thousand and one" little jobs and finishing touches to jobs that can be and ought to be done with a disk grinder. Assume that you have one, say with wheels 12 inches diameter, a plain tilting table and a swinging table, and that you have extra wheels carefully set up with different grades of abrasive circles, so you can select the one best suited for your work. As the wheels are double-faced, with four wheels you can have eight varieties of abrasive circles ready for use at any time. You must be sure that the center part of the wheel, where it fits the spindle flange, is clean and that the flange itself is clean before you put the wheel on. Then the sides of the wheel will run perfectly true and steady, and you can do good and true work on it. On the contrary, if there is glue or dirt between the wheel and the spindle flange, the wheel will "wabble" and will not do good work. The tables are adjustable and can be set to do as nearly perfect work as you are likely to get with any machine in existence.

You have turned and squared up a collar to fit a certain place. You take it off the arbor and find it a little too tight for the place. You wanted to be on the safe side. Now you want it .0005 inch or maybe .0015 inch smaller lengthwise. You step to the disk grinder and get it just as you want it quicker than you could get it back on the arbor.

Possibly this collar has to be hardened and ground to size after hardening. You will do the circular work all right in a universal grinder, but facing both ends would give you more trouble than all the rest, if you had no disk grinder; but as you have, you will face them off in about one-quarter of the time it took you to do the circular work on the universal.

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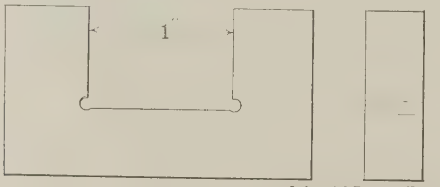
*F. N. Gardner, the originator of the disk grinder, was born September 4, 1848, at Ashfield, Mass. Beginning shop work with John J. Grant in 1866 at Northampton, Mass., he has worked in various capacities from "cub" to manager for Wiley & Russell, Nonotuck Silk Co., Pratt & Whitney, Hartford Tool Co., and C. H. Besly & Co. He has been with the latter concern since 1888 and is superintendent of their works at Beloit, Wis. Mr. Gardner is an expert toolmaker, and his specialties are metal-working tools and special machinery.

It is a common thing to hear men say that such and such a machine will do perfect work. Now, we all know that there is no such thing in machine work as perfection. The best we can do is to make a thing plenty good enough and well within the limit specified. If a thing is plenty good enough, it is perfect to all intents and purposes.

Speaking of the degree of accuracy that can be got with a disk grinder, we can only give a few examples and say that a good workman can do exceedingly close work with it, and if the work is suitable for the machine he can do it easier and in much less time than it can be done in any other way.

An experienced tool maker was with an exhibit of disk grinders at a fair. Having plenty of time on his hands, he employed a part of it in grinding up six steel pieces, each 1 inch square (one-inch cubes). He got the pieces planed roughly in the bar, a little oversize, and sawed off a little long. On his spare time he ground them to one-inch cubes, measuring them with a 1-inch micrometer caliper. When he had finished with them there was no point on any of the cubes that varied more than .00025 inch from 1 inch. Packing them together with any combination of sides, the greatest variation from 6 inches as measured with a 6-inch micrometer was .0005 inch. All the sides of all the cubes were so nearly square with each other that no error could be detected with a hardened steel square. He probably spent 15 to 20 hours grinding on these cubes. Now these cubes were not perfect and nobody wants cubes anyway, but it shows what can be done with a disk grinder and will mean something to a good tool maker. Understand, in grinding these cubes no fixture or clamp of any kind was used. They were laid on the swinging table, and against the rib and pressed against the wheel with the fingers. Any other way will not answer for close work on a disk wheel. The man who made the cubes knew by the way he bore on and by the way the wheel cut, as indicated by the sparks, just about how much he was taking off. It is much easier to know that than it is to know how much you are taking off with a file. As he got down close to size, of course, he had to work carefully, but he had this big advantage over working with a file: The table and rib held the cube true and square every time and the wheel cut all over the surface alike.



Industrial Press, N.Y.

Fig. 1.

Standard end measure test pieces are sold that are guaranteed to be accurate within a limit of 1-50000 of an inch. Of course, you can't handle them with bare fingers and the temperature of the shop must be close to 75 degrees Fahr.; otherwise this limit will have to be extended indefinitely. Such standards are necessary where extreme accuracy of work is required for testing micrometers, beam gages, etc., but they must be kept locked in the safe most of the time and only used on special occasions. They will cost you about $5 each up to 1 inch long and $1 an inch additional above that. With your disk grinder you can make "end measure pieces" that are plenty good enough for everyday use in the machine shop or tool room at a cost of a few cents each.

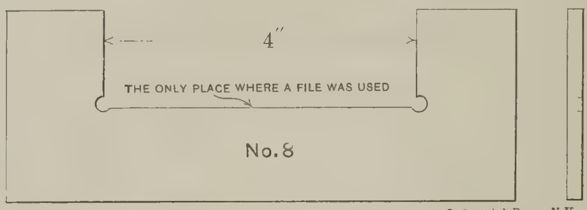
You take ¼ inch or ⅜ inch, or any size you like, drill rod; cut it off say 1-64 inch longer than the size you want. Harden either all over or only the ends according to the length, and then grind to length same as you ground the pieces for centering. You can get it as close to size as your micrometers will measure, and aside from the hardening you can do all the work on it in about ten minutes.

Possibly you have to make a good many snap gages for the turret machine, milling machine, or lathe hands. They are not always very careful with gages, especially if they are on piecework. Suppose you have to make a snap gage something like Fig. 1, which is a common style of home-made gage. Probably you will want to make a neat-looking job, but don't want to waste any time filing, so after you have the notch roughed out, you will go to the disk grinder and finish the gage all over, sides, edges and ends, bevel or round the corners, and make a better looking job of it in ten minutes than you could with a file and emery paper in an hour and a half. You will harden it and it will spring a little, and you straighten it out straight and square again on the disc wheel. Possibly you had best not grind it at all until it is hardened. That depends on how much unnecessary finishing work you have done in the shaper of milling machine.

You are now ready to grind the notch to size. Lay the piece on the swinging table, the back edge against the rib. Let the wheel be in the notch. Grind on both sides of the wheel and do not turn the piece over. This will make the faces of the notch parallel with each other, and they might not be if you turned the piece over end for end. That would depend on whether the top of the table and the rib were exactly square with the side of the wheel, and also on the sides and edges of your piece being exactly parallel. Always use as few "working points" as possible. You will use your end measure piece to get the notch to size. You must be careful not to get the notch too large. Perhaps the safest way will be to make another end measure piece a little undersize, say .0005 inch or .001 inch under size. It will not take you five minutes and may save spoiling the gage. Starting with your standard end measure and your gage hardened ready to grind, you will have the gage finished in fifteen minutes, and how would you do it without the disk grinder?

If you want a nicely finished gage with the idea of inspiring a little respect in the minds of the milling machine hands, you will finish it all over on the disk wheel in about ten or fifteen minutes and make an elegant looking job.

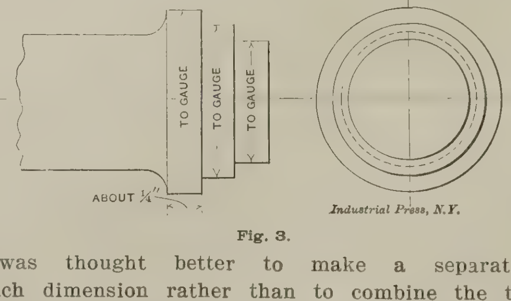
In a certain shop a job came up to be done in turret machines. A large number of cast-iron pieces, about like Fig. 2 had to be machined. There were eight different sized pieces and three dimensions made to gage on each piece, making 24 dimensions in all. The largest dimension on the largest piece was about four inches. The smallest dimension on the smallest piece was about ¾ inch. A few thousand pieces of each size had to be made. Extreme accuracy was not required; a variation of .001 inch was allowable. A tool maker was given the job of making a set of snap gages.



Industrial Press, N.Y.

Fig. 2.

Taking the figures, he made 24 end measure pieces from 5-16-inch round drill rod, hardened them and marked the size. He then cut the gages from ⅛-inch thick sheet steel, something in this shape, Fig. 3:



Industrial Press, N.Y.

Fig. 3.

It was thought better to make a separate gage for each dimension rather than to combine the three in one gage. The working faces were hardened and ground to the end measure pieces on disk grinder, also the edges squared and the corners rounded. The job was not touched with a file except to smooth off the edge in the bottom of the notch.

Time taken in making the 24 end measures of drill rod and the 24 snap gages, ready for use, was 30 hours, and the largest part of this time was used in cutting out the sheet steel and rough machining the notches. These gages were entirely satisfactory. They were used to complete the job and will be used again if required.

You are called on to make a bushing for a drilling jig—old one worn out and they want a new one in a hurry. Bushing is 1 inch outside diameter, 1 inch long, with hole for 33-64-inch drill. How will a disk grinder help you out?

You catch a piece of 1 1-16-inch or larger round tool steel, 3 inches or 4 inches or 6 inches long, in your lathe chuck. Drill the hole, say, 1¼ inches deep, a little under size and bore it true. Round the outer end of the hole and square up the end. Turn outside to 1.001 inch or 1.002 inch and cut off your bushing. Harden the bushing and lap out the hole if it has "gone small." Unless you learned your trade of Noah and are very old-fashioned, you have not left a flange around the top, so you go to the disk grinder and grind the outside to fit the jig. You will do this by setting it on end on the table of the disc grinder, with the squared end down. Press lightly against the wheel and turn the bushing around at the same time. You will have the old bushing to set your micrometers to, or you will keep trying it with the hole in the jig. In either case you must be careful not to get it too small. If you have not left too much to grind you will have it down to size about the time you get the lathe tool marks out. If tool marks are ground out before it is down to size, you will have to test the "roundness" with micrometers and grind on the high sides. The tool marks, while they last, will be a very good indication of whether you are getting it out of round or not. Of course, the less you have to grind, the better, but if you have turned it reasonably close before hardening, you can fit it to the jig in one-quarter of the time it would take to fit it with a universal grinder, and not have to make a special arbor either, as you probably would have done if you had used the universal grinder, which was probably set up for another job anyway.

I don't advise you to depend on a disk grinder for fitting all kinds and shapes of drill jig bushings, but for common sizes and shapes, when you have no reamer for sizing the hole and no arbor to turn and grind them on, and possibly no universal grinder either, you can fit them in this way and with proper care do a very satisfactory job in quick time.

You can use the same method for fitting round punching or drawing dies into the holders after the dies are hardened. In fact, with your disk grinder you can do a very good job of fitting on the periphery of any round piece that has one flat end and whose length is not too great in proportion to the diameter. For fitting and straightening up punch dies after hardening, such as are generally made flat with beveled edges, or for making a true smooth surface on the top of a die where you have to lay it out, it goes without saying that a disk grinder is the only thing.

Just lately we saw a man grinding the planer tool marks off a punching die blank to get a true and smooth surface for laying out the die. The blank was at least 10 by 15 by 1½ inches thick. This was pretty large work for the machine, but he got the surface all right and quicker than it could have been got in any other way.

Setting up a screw machine you get forged tools for cutting off or forming, made of ⅜ by ¾ or ½ by 1-inch bar steel. The bottom edges in all probability are neither flat nor straight and do not seat solid in the toolpost. You go to the disk grinder and make the bottom edge of tool straight and flat in about two minutes. How would you do it without the disk grinder? You would probably leave the tool as it came from the blacksmith, with the bottom edge rounding, and it would get knocked out of position every few minutes.

A man on big planer wants a wide finishing tool, about 2 inches wide on the cut. Without a disk grinder how do you grind it at first and sharpen it when it gets dull? You take it to an emery wheel or grindstone and get it as nearly straight as you can by testing the edge with a straightedge and then you rub out some of the curves with an oil stone. You spend half an hour and the planer man says: "It's pretty fair, but the clearance ain't just right." With a disk grinder you fix the tool in three minutes, and after that, the planer men bother the life out of you bringing around their finishing and slotting tools to be ground.

Think a minute about sizing and finishing nuts and screwheads, fitting keys, finishing key ends, etc., etc., and you will see more and more places where the disk grinder gets in its work in the tool room.

A well-known ex-toolmaker and machinist, who is now superintendent of a large plant, said the other day: "I have known for a good many years that there was some machine missing. I wanted it badly, but I didn't know exactly what the machine was. Now I have found it. There it is." And he pointed to a disk grinder in his tool room.

Also, for sharpening dies and punches—the operation is so simple and the advantage so evident that it would be a waste of time to describe how it is done.

Your humble servant worked twenty years making gages and tools before he ever saw a disk grinder. If he could have had a disk grinder to use whenever he needed, it would have saved years of time. My experience is that a disk grinder in a tool room where only one tool maker is working will be used on the average a dozen times a day and will pay for the investment in the saving of files alone, to say nothing of the saving of time, which is of course many times greater; and, that you can multiply the saving of both files and time by the number of men who have convenient access to the machine. In this talk I can touch only a few of the "high spots" on which you will use a disk grinder in the tool room. The jobs you actually have to tackle are innumerable as the sands of the sea.

* * *

HAMMER DRILL—EXPANSION BOLT.

A simple and effective tool for drilling small holes in brick walls is shown in Fig. 1. It is designed primarily for electric wiremen's use, being employed to drill holes for small expansion bolts. The body of the tool is a steel rod with collars 15 inches apart. Between the collars is the four-pound sliding hammer *A*. The drill *B* is held against the brick wall while quick, sharp blows are delivered against the end of the drill chuck, which at the same time is turned around so as to drill a round hole. It is claimed that a ¼-inch hole can be drilled in brick to a depth of 1 inch in less than one-half minute.

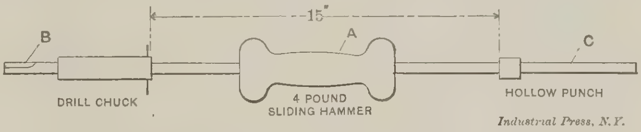


Fig. 1. Hammer Drill for Drilling Brick Walls.

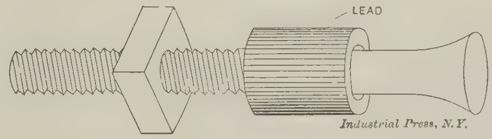


Fig. 2. Expansion Bolt with Lead Bushing.

The Peirce lead expansion bolt, made by the same concern, is then inserted in the drilled hole, head first, and the lead sleeve forced back over the conical-shaped head and expanded tightly in the hole. The hollow punch end of the hammer *C* is employed for this purpose in the same manner as for drilling the hole.

* * *

Skimmed milk is a product of the dairy that has many other uses besides the feeding of calves and hogs. It is made into cheese, glue, putty and many other products, including galalith or petrified milk, that is largely used abroad as a substitute for horn, turtle-shell, ivory, celluloid, marble, amber, and hard rubber. It is used for the handles of knives, for paper cutters, pipes, billiard balls, etc. Skimmed milk is also valuable as the principal ingredient of a primitive paint that has been considerably used in the country for painting barns and outhouses. Another novel use is the making of waterproof glue. One pound of glue melted in two quarts of skimmed milk, instead of water, is said to constitute a glue that resists moisture well.

LETTERS UPON PRACTICAL SUBJECTS.

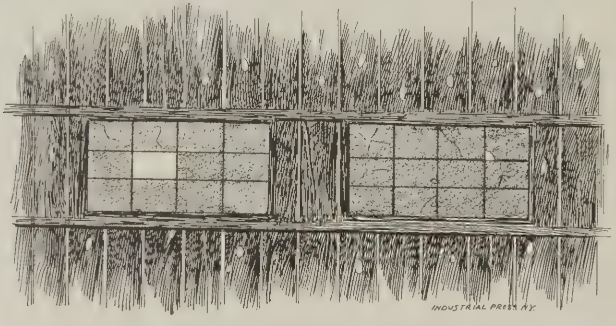
THE OLD SHOP—CUTTING THREADS WITHOUT A BACKING BELT.

Editor MACHINERY:

In knocking around I went to work in a shop away out in Nowhere, and there were several funny things there. One was the windows. They could only be seen from the outside. The panes were set with the length horizontal instead of vertical. Over the shop door was a sign very much worn by the weather, on which, after a close inspection, if one's eyes were good, the following could be seen:

NOTICE.
NO ADMITTANCE; APPLY AT THE OFFICE.

I always thought that the sign was to prevent visitors from being lost in the semi-darkness of the interior, which looked something like this:


INDUSTRIAL PRESS N.Y.

Where the Windows were Never Washed.

The clean square in the window to the left is not a broken glass; one of the boys started to clean it when the Old Man stopped him. The clean spots in the wall are knot-holes in the boards. Please note the cracks—we did when the mercury was trying to get down in the bulb to keep warm.

One day one of the boys saw something posted up on the wall. He got an old bag, tied it to a stick and used it to brush off the dust, and then we saw it was a printed set of rules. One of them read like this:

"This shop must be kept in a clean and orderly manner."

The boys are all scattered far and wide now, but if any of them reads this he will recognize it right off, for that was a great day.

I saw one of the men in that shop one day cutting a thread about 16 inches long and about 8 pitch in a lathe that had no backing belt, but it did not stick him. He pulled the belt back by hand! The same fellow said that MACHINERY was no good; he could not be bothered by reading it.

It is surprising how many there are who do not know of any way out of the same difficulty, but it is simple. Stop the lathe and run back even inches after opening the leadscrew nut. Put a mark on the faceplate and one on the leadscrew gear, run back to the same point every time, and when the two marks are in conjunction, when sighting at some point beyond the leadscrew gear, close the nut. Care must be observed at first, but a little practice will make it easy. Or we can run the thread upon the work as far as it is to go, then run the carriage back even inches and set a stop. Then when we run up to the end of the thread again, open the nut without stopping the lathe, run back to the stop and when the work has made as many revolutions as there are threads per inch, from the time the nut was opened or a multiple of the same, then close the nut and see if it don't work.

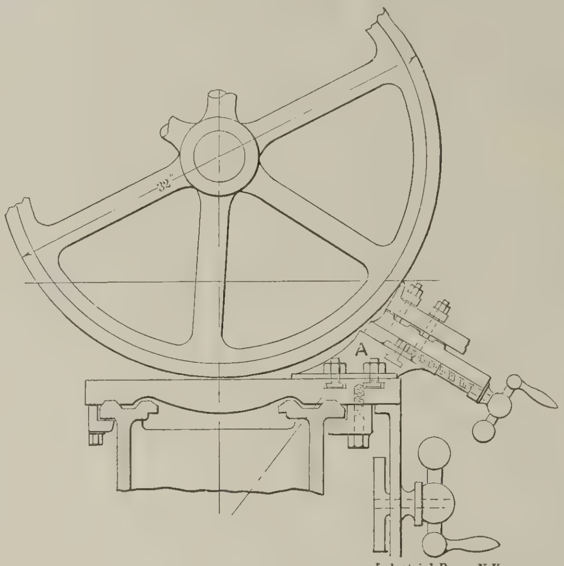
Elmira, N. Y. JOHN A. BURGESS.

TURNING A THIRTY-TWO INCH WHEEL UNDER DIFFICULTIES.

Editor MACHINERY:

Regarding the article in the February issue of MACHINERY by Mr. Frank B. Kleinhans, on the chattering of lathes, I would tell your readers of a makeshift which was employed by one of the lathe men who was turning and finishing a 32-inch wheel, and which, under the circumstances, answered very nicely.

Our largest lathe is a 24-inch swing and when this job came in to be done the head and tailstocks were blocked up, of course, in the usual makeshift manner, and on account of the "overhang" referred to by Mr. Kleinhans, it appeared to be impossible to avoid the chattering.

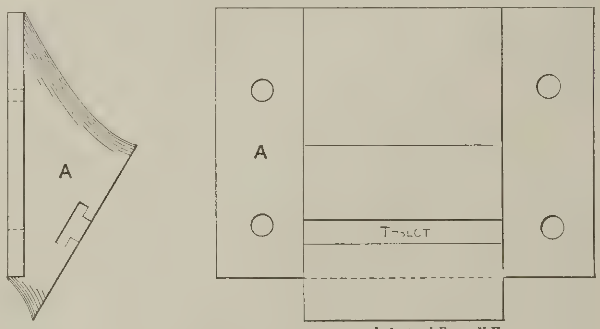


Industrial Press, N.Y.

Fig. 1. Rig for Turning Work Larger than Swing of Lathe.

After trying various tools the man at the lathe crossed the belt and ran the lathe backward, turning the cutting tool bottom up. He was able, working in this way, to turn out a very neat and smooth job.

If we had intended to turn out many of these 32-inch wheels we should have made a special tool-post bracket with the arrangement as per sketches submitted herewith which I have used many times before. It consists of a casting marked *A*, the only extra piece needed for this device, which is designed to fit the carriage, also to fit the tool slide that is already in use on the lathe.



Industrial Press, N.Y.

Fig. 2. Bracket for Tool Slide.

It will be seen that with this arrangement all of the chattering will practically be done away with, or in other words, all the chatter now to be found will be between the lathe spindle and its bearings. It also will be noticed that a right angle taken from the line joining the lathe center and the cutting edge of the tool, will point to a line inside of, or between, the ways of the lathe.

A. D. KICKER.

JIG FOR BORING ROUGH CASTINGS.

Editor MACHINERY:

Probably no class of work has given the jig designer more trouble and less satisfaction than cast gears. If they are spur gears and it is attempted to hold them concentric with a bushing for boring in anything like a ring of fixed diameter, it will be found, if they are hand molded, that rapping has taken place more in one direction than in another. Consequently the gears may fit one way, but be seriously loose another. Again, if they are machine molded, in which case rapping has not to be contended with, there is variable shrinkage and fins and lumps that will not allow of any close fitting receptacle of fixed diameter. The work from a certain molder may go in to-day, but another man takes the pattern next week with perhaps the result that the work goes in too loose or will not go in at all, or only a certain percentage goes in.

It may be that the purchasing agent thinks he has gotten a good thing on a new lot of iron, and before the foundryman has gotten his mixture down fine a lot of gears are out. Very likely some one will say that these things ought not so to be, but we know from experience that they do occur; the gears are made and have to be bored, and have to be assembled, so as to run smoothly. How can this best be accomplished?

The writer has some time since become convinced and has proven to his satisfaction that cast spur gears should be held from the outer ends of the teeth at three points as nearly equally spaced as possible, and that the holding should be done by jaws moving to and from the center. The outer ends of the teeth are selected because they are less liable to distortion by the washing of sand and by swelling than other parts of the teeth, and any slight lumps are much more likely to be removed in the tumbling barrel from the ends than elsewhere.

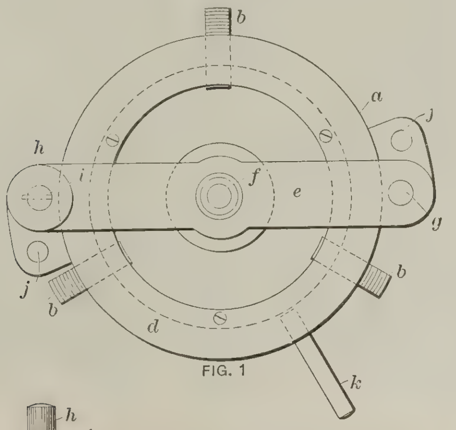


FIG. 1

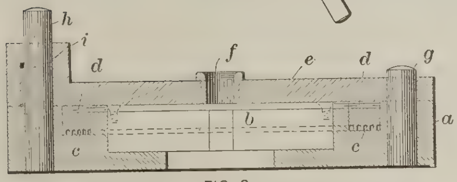


FIG. 2

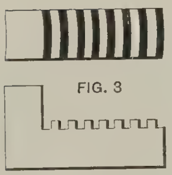


FIG. 3

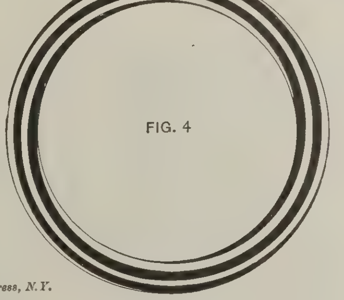


FIG. 4

Industrial Press, N. Y.

Jig used in Agricultural Works for Boring Rough Castings.

Again, it is much more convenient to hold them from these points than otherwise. If three equally spaced points in the periphery of a gear are held true with the jig bushing, all intermediate points must be well located for the boring operation. In placing the gear in such a jig it is quite within reason to expect the workman to observe three points when he would not look over the whole circumference. In our case where the gears working in a certain nest were jigged as described the cost of assembling, that is to say, keying to shafts, babbitting bearings for shafts and bolting up so as to have a free running set of gears, was reduced exactly one-half from the former piece-work price.

The manner of holding as described, the writer has accomplished by several devices. One of these has been a special form of scroll chuck. The same jig chuck may be made to accommodate different sizes of gears within a limited range with, it may be, the exchange of bushings.

Figs. 1 and 2 show top and sectional views of such a jig. Referring to these figures, *a* is the main body casting, which is planed to receive the three steel jaws *b* and turned to admit the scroll ring which will be seen at *c*, while *d* is a steel ring used to retain the jaws and scroll. At *e* is seen the cross-bar for the support of the bushing *f*. This cross-bar is held in place by two guide pins *g* and *h*. The latter is longer than the former, so that when a gear is to be removed from the jig the cross-bar may be raised only sufficiently to clear the short guide pin and then swing aside upon the longer one. The end of the cross-bar engaging the long pin is provided with a boss of sufficient length to insure a parallel movement and prevent cramping. At *i* will be noticed a pin driven into the tall guide pin and left projecting into a slot. This acts as a stop to prevent the cross-bar from slipping down again when swung aside until again brought into line with the short guide pin. At *j* are seen holes for attaching the jig to the drill press table. A handle for revolving the scroll ring is shown at *k*. Fig. 3 represents two views of a jaw and Fig. 4 the under side of the scroll ring.

For gears that are to be tapped the twist drill will of course answer for sizing the hole. Where a variation of bore of .008 inch, or more, is permissible the four-lipped twist or straight flute drill will give good service, but if closer sizing is required a finishing reamer may be used after the truing of the hole has been accomplished through the bushing. If greater accuracy is desired than can be had from simply a bushing, a piloted tool with support below can be added It is sometimes possible to make the bushing turn within a bearing, thus saving much of the wearing away of the clearance on drills, which will occur rapidly if holes are cored eccentric as often happens.

When gears of large enough diameter and with dished arms are to be bored the jaws of jig may be reversed, placing the shoulders outside of scroll ring with the guide pins coming up between arms, in which case the cross-bar is made lighter and will be completely removed when work is to be changed. In this way the weight of a jig may be kept at a minimum.

For the machining of the scroll ring and the teeth of jaws. the lathe, by a little contrivance and calculation, may be arranged with a geared cross-feed of suitable ratio. It must be remembered that the teeth of the jaws are of a spiral the reverse of the scroll ring and they will need to be relieved at the ends if the jaws are to have more than a slight movement. The jaws can first be fitted tightly into body casting for cutting the teeth and then be relieved sufficiently to secure free working.

CYRIL B. CLARK.

Springfield, Ill.

FINDING THE HEIGHT OF A SMOKESTACK FROM ITS SHADOW.

Editor MACHINERY:

Having been one of the many readers of MACHINERY for the past few years, I have been very much interested in the articles contributed from time to time, especially those on "shop kinks," as they seem to give a snap to one's "thinker," and having had a little problem to wrestle with a short time ago, I wish to submit it to your many readers, hoping that some time it may come in handy to them, which I am sure it would, provided they should run up against the same snag that I did.

About a year ago, while I was with a prominent automobile company, as chief draftsman, the superintendent came into the drafting room one morning bright and early and wished to secure the approximate height of the smokestack on the factory, as it was in very bad condition and the company wished to erect a new one. Now, the idea of having to measure the height of a smokestack without an instrument suitable for that purpose seemed like a vision. At first it seemed as though about the only way out of it was to secure the services of one who possessed an instrument, which would mean considerable time and expense, and to measure the stack with a tape line or yard-stick was simply out of the question altogether. But after pondering over the problem for a short time an idea came to me that proved very successful and which solved the problem. I went out into the yard, secured a pole and had it cut to exactly eight feet long, which afterward I held in an upright position with the end resting upon the ground so that the pole would cast a shadow in relation to the smokestack. My assistant measured the length of the shadow cast by the pole, which was found to be four feet (shadow being measured on level ground). We then measured the length of the shadow of the stack in the same manner, which we found to be eight feet.

Therefore, if the pole was eight feet long and cast a shadow four feet, a pole one foot long would cast a shadow one-half foot long. As the shadow of the stack was eighty feet long, the height of the stack would equal as many feet as one-half foot is contained in eighty feet, which is one hundred and sixty feet, or the height of the stack from the ground. Taking from this forty feet, the height of the building, gave us 120 feet, the length of the stack proper. W. E. GOULD.

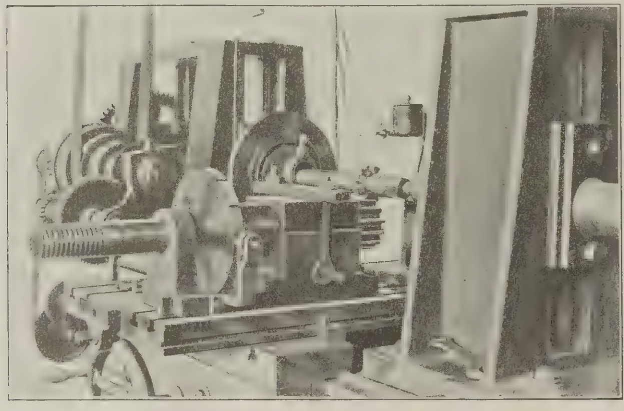
Detroit, Mich.

RIG FOR MILLING PINION TEETH.

Editor MACHINERY:

We had occasionally to cut pinions twelve teeth, three pitch, on the end of a crucible steel shaft about 32 inches long. The body of the pinion was 4¾ inches diameter; the shank, 2 11-16 inches.

We had been cutting these on an old style No. 4 Cincinnati milling machine, using extension plates bolted to the table to separate the centers far enough to take in the work. This made a rather limber rigging, and we found that to use the automatic feed we had to take three or four cuts, and the time required was about thirty-three hours on each one.



Rig for Milling Pinion Teeth on Horizontal Boring Mill.

We then built the holder shown in the cut. This consists of a solid casting tongued and bolted to the table of a Pratt & Whitney horizontal boring machine. This has a cap and is bored out to fit the body of the pinion. The cap is bolted down, as shown in the cut, by two eyebolts connecting to a rod through the body of the casting. When we want to take off the cap we loosen the bolts, pull out the rod and lift it off. We index by a plate setscrewed direct to the shank of the pinion. Thrust of the cut is taken through the index plate to the bearing back of it, which is cast solid with the main bearing. Feed was effected by a "small boy." He did not like the job, so we got them out in nine hours each, and got a good, smooth job, too. E. H. FISH.

Worcester, Mass.

THE VALUE OF THE AIR-DRILL IN REMOTE SHOPS.

Editor MACHINERY:

I have several very good wrinkles in machine tools and appliances which your readers, especially foremen who work in a general machine shop such as ours, would be very glad to see. The first (which is something more than a wrinkle) is in connection with the "Little Giant" air drills, of which we have two; it is really surprising the amount of work that can be done with them, when fitted with the "fixing" shown in the cuts.

Fig. 1 shows the machine and knee (the knees are made specially for the drills) fixed on a loose table; it is now practically as good as a radial drill. You will notice a split collar under the radial arm, which acts as a stop to prevent the radial arm sliding down when being revolved round the vertical post. When this photograph was taken we had a large government contract for railway goods wagons, and all holes in the iron work were drilled in jigs; not one part was allowed to be punched. So we fixed up the two drills as shown, and I can assure you we turned out as much work with them as we did with our two radial drills which were on the same work. The fact is they saved the cost of two new radials, which would have been of no further use to us after the contract was finished. Another advantage was we could use the machines in any part of the shop, and when the drilling got behind we simply ran the air drills two shifts of 10 hours each; we then only had to run the air compressor all night instead of the main engine, which you can see was a great saving in fuel. As shown in Fig. 1 the drill moves along the radial arm in a feather way, which always holds the machine in an upright position. I may state the feed is 5½ inches, but, of course, it can be made any length. The cost to us of the fixing complete for the two machines was about $105. I am sure the makers, if they took up the idea, could make the gear and knee complete for one machine for less than $20. All our parts were forged, which soon runs into money, but with your people some parts would be malleable cast, and others stamped forgings.

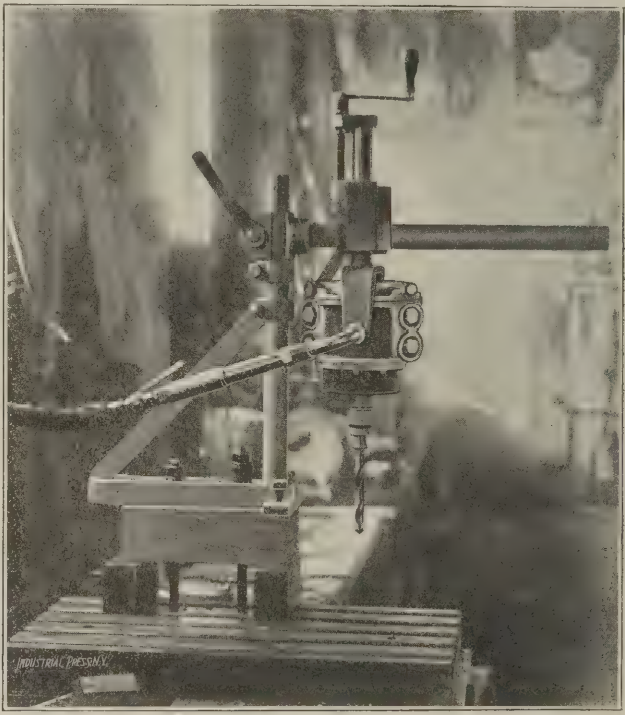


Fig. 1. Air Motor Drill Mounted on Radial Arm.

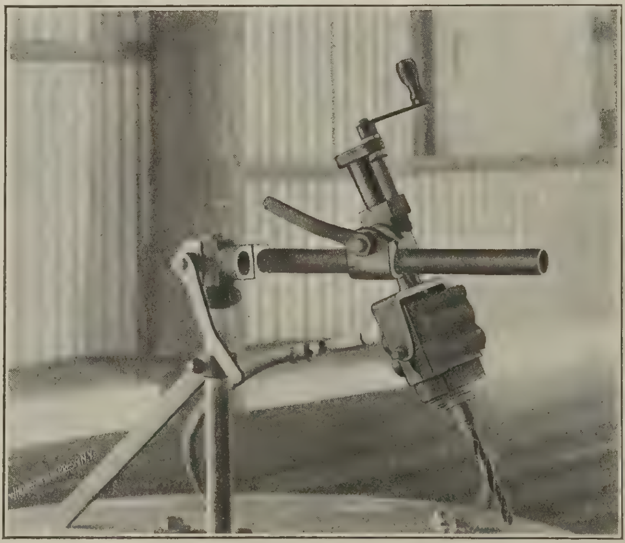


Fig. 2. Use of Air Drill on Boiler Heads.

Fig. 2 shows the drill fixed on a boiler end, ready to drill rivet holes for gusset stays and gage cocks; the steady-pins and feather have been taken out of the swivel head to show that holes can be drilled at any angle.

Fig. 3 shows both drills at work in a boiler shell. The shell is 9-16 inch thick; butt joints; fitted with cover plates inside and outside; triple riveted; working pressure 140 pounds; test pressure 220 pounds; holes punched ⅝ inch and drilled in place to take ⅞-inch rivets. You will notice the drills are hung on a 4-inch boiler tube, and can swing round the whole circle, but in practice it is better to work at the bottom of the shell, for a distance of one-sixth, say, of the circumference, and then turn the shell on the rollers, because in that position it is easy to supply the drills with lubricant. The star center (of which there are three) for supporting the 4-inch tube, will fit boiler from 5 feet 6 inches to 8 feet diameter. The tube is made full length of the boiler, and the drill is only hung on end of tube while drilling six holes in from the end of the shell. When they are done, the drill is slipped off the tube, two of the screws in star are slacked back, star is removed, drill slipped on, star replaced, the two screws tightened and all is ready for work again. You will notice that the gear is so made that the holes must be drilled radially and that the machine is balanced in any position when drilling; the machine is not held in any way. When one hole is finished the machine is simply pushed along the tube to the next hole, or swung round, as the case may be.

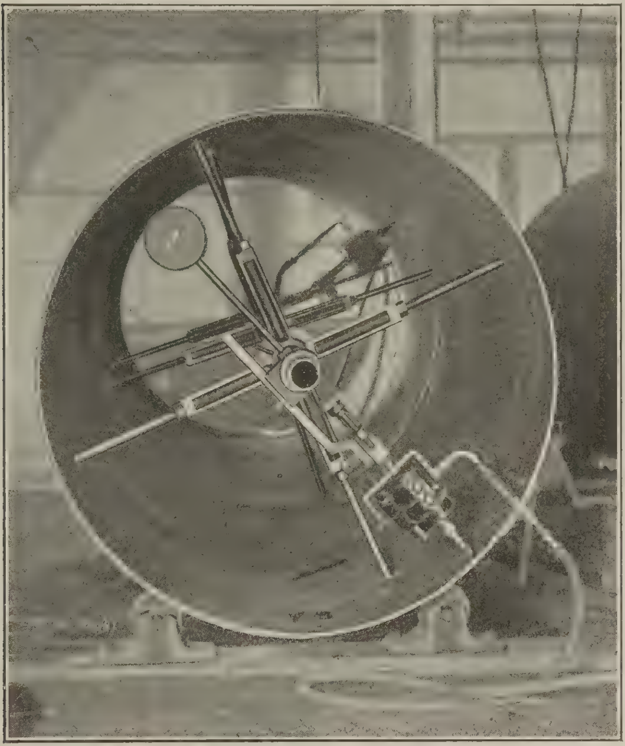


Fig. 3. Rig for Drilling Staybolt Holes.

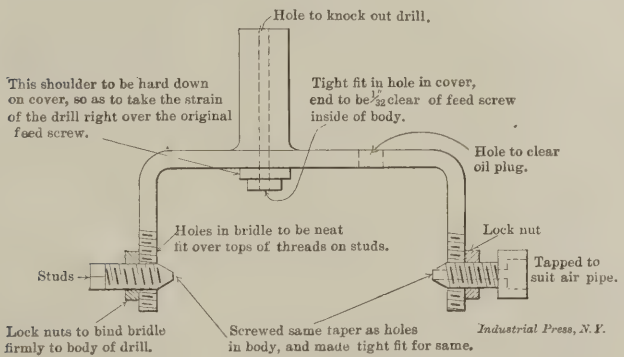

Hole to knock out drill.
This shoulder to be hard down on cover, so as to take the strain of the drill right over the original feed screw.
Tight fit in hole in cover, end to be 1/32″ clear of feed screw inside of body.
Hole to clear oil plug.
Holes in bridle to be neat fit over tops of threads on studs.
Lock nut
Studs
Tapped to suit air pipe.
Lock nuts to bind bridle firmly to body of drill.
Screwed same taper as holes in body, and made tight fit for same.
Industrial Press, N.Y.

Fig. 4. Bridle for Mounting Air Drill.

As I said before, this is something more than a wrinkle. I am sure if the air machines were fitted with this gear there would be a great demand for them. The great fault with the drills as now put on the market is the difficulty of holding the machine when the drill is going through the work, especially mild steel, brass and copper. I would like to see the two men that can hold the machine when drilling a 2-inch hole through mild steel, but with this rig it is just as easy as in a radial drill.

To give an instance of the value of these air drills when fitted with the bridles, we have just finished a tandem compound engine L. P. Cyl. 25 inches diameter, bed 31 feet long, Our usual way was to carry the bed, with cylinder, guide bars and bearings attached, to the big radial drill, and shift it about so as to reach all holes. That style you know means expense, but now, when the bed is once laid on the blocks it is not moved until ready to leave the work. The turned bolts for fixing cylinder to bed were 2 inches diameter. We drilled the holes 1 15-16 inch diameter, and then put in the 2-inch rose-bit without shifting the machine; the holes, of course, were just as good as when done in the radial, and at one-tenth the cost. Of course when drilling in a confined space we take the bridle off and use the original feed and make the best of it. I may state the gear can be taken off and put on again in less than two minutes. The rough sketch of the bridle, Fig. 4, will show how it is made and why it is so firm and strong. Of course the arrangement would be much more simple if the body casting was made to suit. W. PARRY.

Bundaberg, Australia.

CUTTING OIL-CHANNELS IN BEARINGS—OIL-CHANNEL CHISELS.

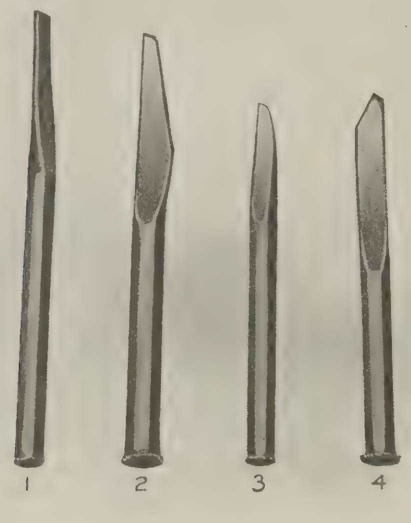
H. E. Wood.

Editor MACHINERY:

Many times the question has arisen as to the proper specifications of an oil-channel. Having had a broad experience with these little "friends" of machinery, I find that it is decidedly necessary for an oil-channel to have an opening at its extremity so as to permit the air to pass out, thus leaving the way clear for the oil to follow into the space. A large number of machine manufacturers seem to be making the common error of putting a channel in the bearing leading from the oil hole (which should be in the center and at the top of the bearing) out to within ¼ or ⅝ inch of the end of the bearing. When they do this, and put the machine together, oil it up and start running it, the oil will go from the oil-hole to the end of the channel and stop (provided there is space enough between the shaft and the bearing to permit the air to escape). The person who does the oiling has no evidence to tell him if the oil has reached its destination or not. What are the consequences?

The answer is, that at once the fine particles that wear off from the surfaces of both shaft and box, together with the dust that is apt to settle into the oil-holes, all accumulate in the channel and are constantly washed and forced up or out toward the end of the channel until they lodge at its end. It takes only a short time for this substance to fill up the channel completely; then the shaft gets no oil only at the oil-hole itself, which also gets stopped up so many times and causes no end of trouble and expense.

Whereas the above facts can be seen by a careful observer, let it also be observed that if the machinist had cut the channel through to the outer end of the bearing there would then have been a free and unobstructed channel for this dirt or substance to wash out and away. It also acts as an indicator for the person who puts the oil in; he knows when he puts oil in the center and sees it come out at the ends that he has oiled the entire length of the bearing. In addition to this let it be noticed that if there be a hub or gear or pulley of any kind at the end of the bearing, it then becomes necessary to cut the channel up the side of the box to the open space. This then gives the oiler a response for what he has done, or in other words he knows that he is oiling an open channel and that it is not clogged up. When the careful operator of a machine thus provided with open channels, sees that the riser or outlet vent offers no response, he will then at once proceed to find out why. Many times when the bearing has a pulley or gear against one end and a collar against the other end, such as is often the case, and the channel has by some reason become stopped up, the collar may be slipped endwise on the shaft away from the bearing and a wire run through the channel will quickly clean it out. Again when the shaft or pulley gets to cutting or is "stuck tight" and a machinist is called to remedy the trouble, his first move is to put kerosene oil into the oil-hole; then if it does not start loose he will squirt the kerosene on at the ends of the bearing, in hopes that it will reach the spot that is cutting, and if at this critical time he finds a channel down at the end of the bearing, he stands a good chance of getting the oil onto the affected part.

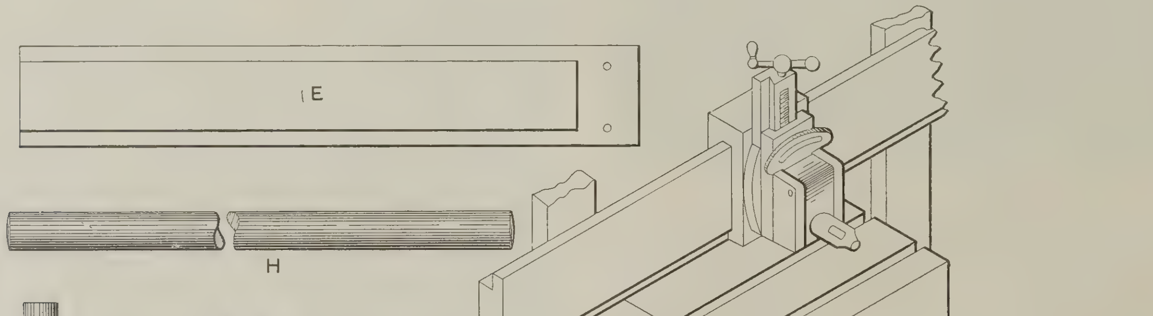


Types of Oil Groove Chisels.

The objection may be raised that if the oil channel is cut all the way through the box or bearing, the oil will run out, and of course it will; but the fact is that a few drops of oil will wear many hours on a shaft running at ordinary speed, and by the time enough oil has been put into the oil-hole so it runs out of the ends, there must be enough oil left on the shaft to run it until time for the next oiling up. It is a well established fact that if a bearing is oiled at each end only, the oil will form an air-tight collar around the shaft, and the result is that the oil never gets to the center of the bearing; hence the converse of the proposition is to put the oil in the center and provide channels so it can escape at the ends. The owner of the machine can better afford to waste a few drops of oil, than to have his oil channels plugged up and stop the oil from doing its duty.

In connection with this subject I have made a close study of chisels, both for flat and round nose. I have especially taken notice of the peculiar sort of oil-groove chisel used by 90 per cent. of machinists with whom I have worked. I send you a photograph of four round-nose chisels usually used for cutting oil-channels. No. 4 is what I call the correct shape; it will be noticed that the cutting edge is in such position that when in use its center is slightly above the axis of the chisel. This position will admit of the chisel taking a heavy blow and not springing out of place.

All machinists will agree with me that it is usually impossible to chip an oil-channel straight and smooth; what is the reason? When the chisel is hit with the hammer it springs and vibrates; that is why. If anyone will grind his chisels to the shape of chisel No. 4, he will be surprised at how smoothly and easily it will cut. This shape chisel can be used equally as well on outside or flat surfaces, as it can on the inside of a hole; it can also be used as a "center-drawing" chisel on the drill-press with good results.



Arc Planing Attachment.

No. 3 is next to the best one in the group because its cutting edge comes the next nearest to the axis of the body, but it cannot be used with good success on a long flat surface as No. 4 can. No. 1 and No. 2 show about the average shape of round-nose chisels, as used by nine out of every ten machinists you meet with.

Therefore, I would request any fair-minded machinist who uses a round-nose chisel to fit one up in the shape shown by

No. 4, and try it, and if he is not satisfied with the results I should be very glad to hear from him, either through the columns of MACHINERY or by correspondence.

Pearl River, N. Y. H. E. WOOD.

ARC PLANING ATTACHMENT.

Editor MACHINERY:

The attachment described in this article, while it may be an old story to some members of the trade, I think will be new to some others. I have never found but one in all my travels. The building up of large circular dies for blanking out sectional parts of electrical apparatus, had grown to such an enormous extent in a certain shop that this attachment was designed to do the planing on the circular parts of such dies. It can be adapted to almost any planer, and work of almost any radius can be done on it.

Referring to the assembled sketch, *A* is the platen of the planer; *B* is a pivot plate bolted to the same, and on which the dovetailed part *C* swivels; *D* is the work platen fitted to slide on the part *C* and also provided with T-slots; *E* is a dovetailed rail attached to the upright of the planer and standing off at right angles with the end supported by a short post on the floor; *F* is a movable pivot fitted to the rail *E*. The piece *G* is journaled to pivot *F* and provided with an eye to take the round bar *H*, which latter fits into a socket on the end of the work platen *D*, and completes the attachment. The principal parts of the attachment are also shown in separate views in the same cut.

In operation the work is bolted to the work platen instead of the planer table which, being attached to the bar *H*, swings on the pivot *F* and carries the work on a circular line instead of straight. The radius is obtained by moving the pivot *F* and adjusting the tool on the planer in the usual way.

The work done on this attachment must, of course, be limited as to length, but is otherwise very satisfactory, as you can plane either the inside or outside of the circle, as will readily be seen by the sketch. PRACTICAL.

SET OF TOOLS FOR A MANUFACTURING OPERATION.

A. L. Monrad.

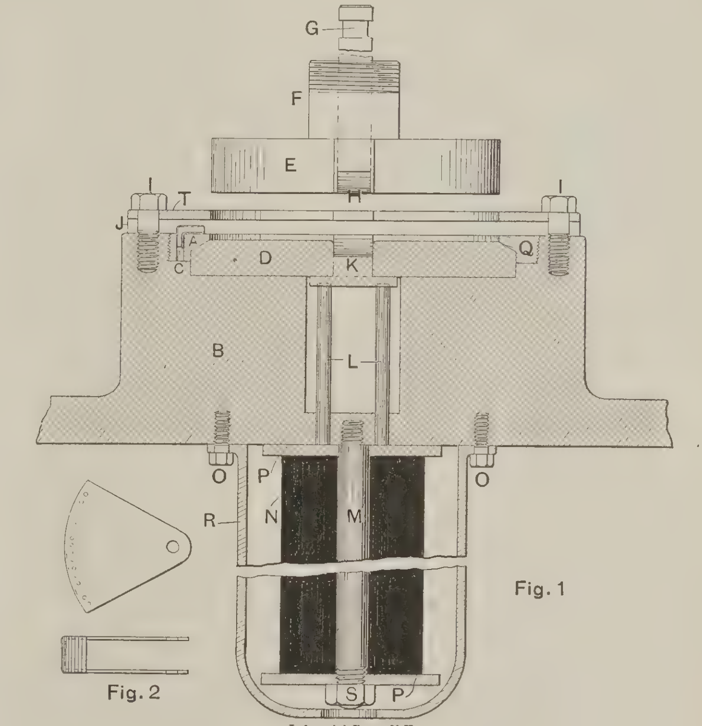
Editor MACHINERY:

In the article herewith a double-acting punch and die, and an indexing drill jig will be described. These have replaced the old ones, and have increased the quantity and quality 25 per cent.

In Fig. 1 is shown an assembled sectional view of a punch and die for a double-acting automatic press, for blanking and forming a piece from sheet metal, 2⅞ inch wide, and .037 inch thick, of the shape shown in Fig. 2. The blanking die *A* is of tool steel turned and threaded to fit the cast iron die bed *B* and is made with a stop-pin hole *Q*, and another in the opposite side to fit a spanner wrench. In the center it is worked out to fit the blank, and with an angle of 60 degrees on the bottom, to match with the forming die *D*. In making the blanking and forming die the construction of the first is made independent of the other, for the reason that the bottom or forming die *D* has to be replaced much oftener than the top or blanking die *A*. Before making the blanking die it is necessary to ascertain the proper shape of the blanks, which must be such as to form into the desired shape for the finished piece after passing through the drawing die. This can be calculated very closely by men accustomed to this work; but can, however, easily be found by filing out a few pairs of approximate blanks and trying one of each pair in the forming or drawing die, and when the desired shape is found, making the blank die to the mate of the suitable blanks. The drawing punch *H*, blanking and drawing die *A*, *D*, are hardened but not the blanking punch *E*, which can be upset when worn. An inclined open-back press of an angle of 45 degrees is used, to let scraps and the work fall off by their own weight into two different boxes on the floor.

In this kind of double-acting press tools, the punch *E* cuts the blank and holds it firmly on the top of the die *D*, and then the punch *H* descends and draws the blank through drawing die *D* and bottoms on knockout or former *K*, which forms the arc shape. The tension for holding the blank while being drawn up with the punch is received from the rubber spring *N*, which is adjusted with the nut *S* on the bolt *M*, and is embraced by the two steel washers *P P* on the top and bottom. On top of the upper washer are placed four pins *L*. These go through the cast iron die bed, and fit into the blank holder *K*. The blank being held between the face of the punch *H* and the knockout *K*, the punch in descending causes the rubber *N* to compress, and continues downward 2¾ inches. The mechanism below is inclosed by the cover *R*, which is secured with two screws *O O*; a hole is provided in the bottom of *R* to adjust the nut *S*. On top of blanking die is placed the gage plate *J*, made the right width of the blank, which latter is of such width that the punch cuts out the triangular part only, on each end. A stripper *T* is shown on top. Both are fastened to the face of the die by the two cap screws *I I*.

The double-acting cam press is equipped with the Bates automatic roll feed. The blanking punch, shown at *E*, has a straight shank, which is threaded at one end, and is held securely in the punch holder by a threaded ring or a collar. The forming punch *H* is secured to the gate of the press by a yoke key at the shoulder *G*, and as the gate with the punch ascends the piece is stripped from the punch *H* and deposited in a box on the side. The blanking and forming die is hardened and tempered; the cutting edge is internally ground to size and tapered ½ degree. The cost of these tools is quite a little more than the old timers, but the extra cost is offset by the surprising results.



Figs. 1 and 2. Double-acting Punch and Forming Die; also Work Produced.

Fig. 3 shows an indexing drill jig, for drilling the part, Fig. 2, which has 17 holes on a radius of 2 3-16 inches. These holes must be spaced accurately and equally apart. The body *A*, Fig. 3, is of mild steel. After being machined out to the right shape, the two bushing holes are bored at the same setting, and a boss is turned on the side to fit the lever *B*, which is threaded to receive the nut *C*. This nut has two holes on the side to fit a spanner wrench and is screwed up to a shoulder, but the lever *B* must be a close fit. The part *A* is now placed on a hardened and ground arbor between centers on the milling machine and the sector is cut in 17 divisions, one side of the cutter being radial and 1-16 inch from the center, while the other side is at an angle of 25 degrees with the radial line. In most cases the index head of the milling machine will be found "out," the error being .002 to

.005 inch (?). To overcome this the radial side is made the working side and the error is eliminated after the jig is finished and a sample drilled. A gage is made the width between the two holes. If the holes are found "out" the radial side of the index plate is scraped until the gage enters right. The body *A* is now hardened and if any imperfection is found after casehardening it is lapped on the radial side until the gage enters. This style of slot, having one side radial, gives the greatest accuracy in use because chips or dirt do not easily lie on the radial side since the index finger or plunger tends to shove everything off this face as it enters the slot, and if a chip does get on the other face its presence does not affect the setting because the plunger is forced tight against the radial side.

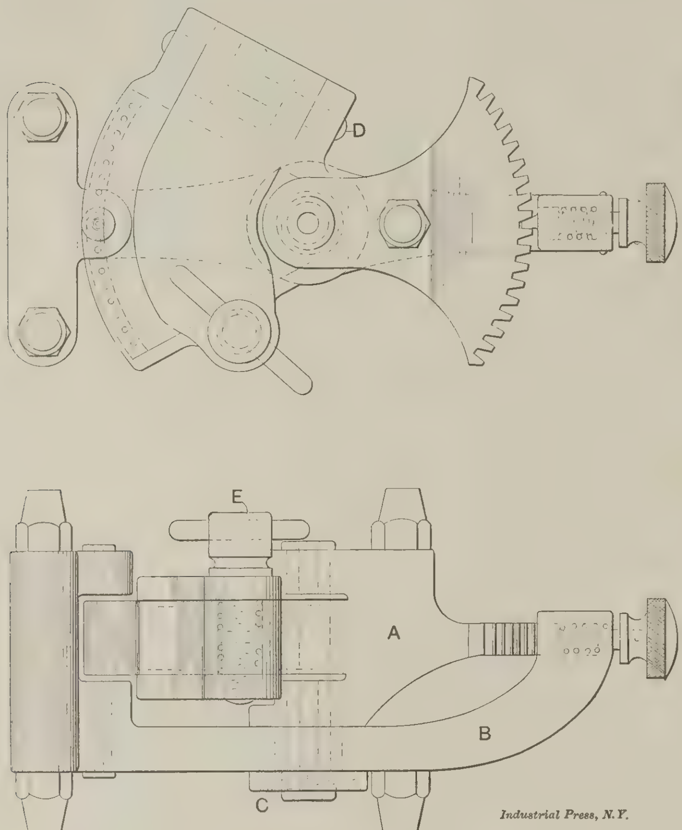


Fig. 3. Indexing Drill Jig.

The index lever *B* is made of machine steel, and is made a close turning fit on the boss turned on *A*. The location of the bushing holes is obtained from the model after the jig is assembled, and the holes are bored at the same setting. The indexing mechanism consists of a round plunger, which is hardened, ground and lapped at the end to a perfect fit in the slot of the indexing plate.

The clamping device is two straps made of machine steel and casehardened; they are jointed and held in together with a pin *D* on the body *A*. On the other end it is fitted with a screw *E*. This is screwed into the bottom strap, and two spiral springs are placed between the two straps to keep them in an opened position when the work is entered. The action of the screw *E* clamps both sides at once. A triangular recess .030 inch deep is planed out of both sides of *A* for the reception of the holes to be drilled; the ledges at the sides keep the work in right position for drilling. On the outer edge an arc is milled on both sides .020 inch deep and a little beyond the holes to prevent the burr sticking in the holes after drilling, and permit the parts to be easily removed.

A. L. Monrad.

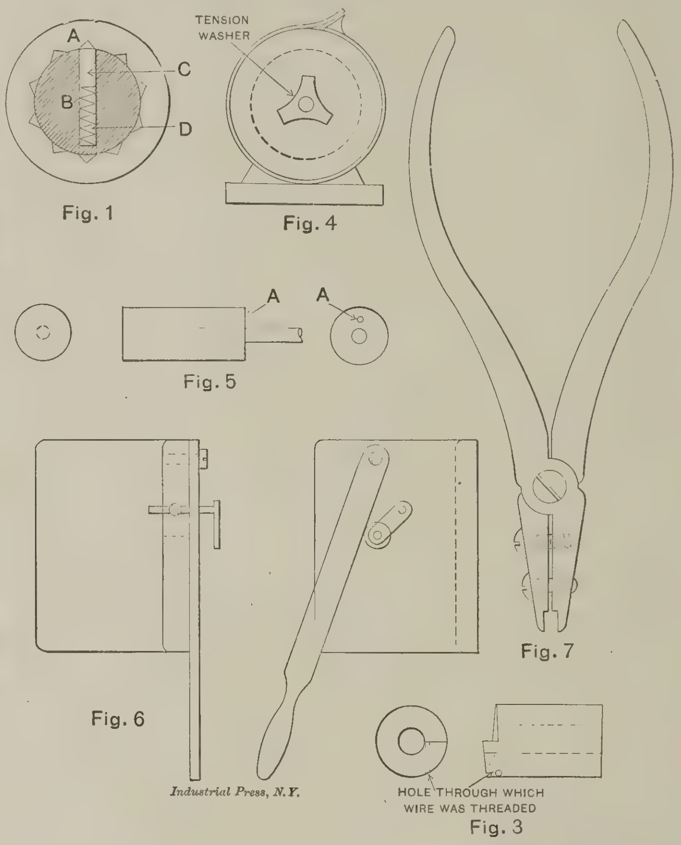
New Haven, Conn.

AN EXPERIENCE IN MAKING SMALL COIL SPRINGS.

Editor Machinery:

Some time ago our firm took a contract to make 5,000 sets of certain parts of a numbering stamp and before we finished the job we had all sorts of trouble, both expected and unexpected. One of the parts was a small open helical spring. It was made from piano wire, No. 7 music wire gage, and was 13-32 inch long by .108 inch outside diameter. There being six in each machine, 30,000 were required but we thought best to make 5,000 extra for good measure. Before we finished, another order for 25,000 was received, so we made 60,000 altogether.

Fig. 1 shows how the spring was used. *A* is the type wheel, *B* the shaft on which it revolved, *C* the blocking pin, *D* the spring in question. The type wheels were revolved by a pawl and when in position, the pin *C* prevented them from shifting and getting out of line but still allowed the pawl to revolve them quite freely.



Appliances used in Making Small Coil Springs.

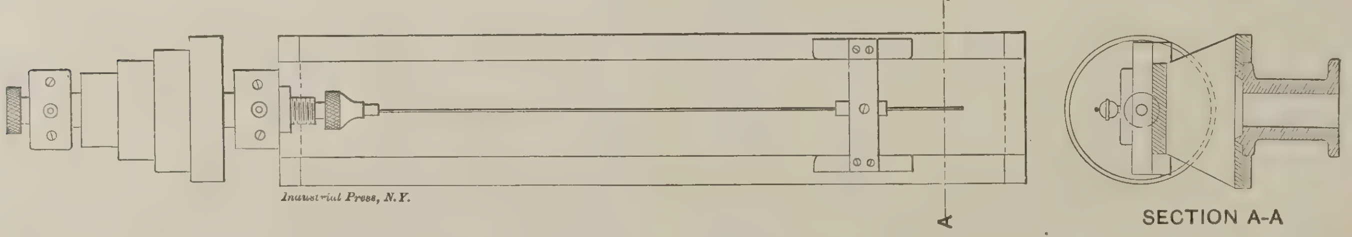


Fig. 2. Disposition of Lathe for Winding Small Springs.

The springs were wound in a speed lathe, using a piece of drill rod 3 feet long for a mandrel. Fig. 2 shows a general view of the winding device and Fig. 3 an enlarged view of the guiding sleeve. To prevent the wire springing open and getting tangled a reel shown in Fig. 4 was made. On the end of the mandrel was soldered a short piece of ⅜-inch round brass as shown in Fig. 5, in which a small hole, *A*, was drilled. This piece of round brass was held in the lathe chuck and the mandrel lay extended on the board slide shown in Fig. 2. The guiding sleeve was then slipped over the mandrel and brought close up to the chuck, when the wire was threaded through the hole in the sleeve, the end bent at a right angle and caught in the hole in the brass rod. A few turns were made by pulling the belt, after which the power was applied. As the spring was wound it forced back the slide carrying the guiding sleeve and just before it reached the end of the mandrel the lathe was stopped and the wire cut. A pull of the belt then wound the short end of wire and drew it through the hole in the sleeve. The sleeve was then slipped off the mandrel, the wound spring removed and the operations repeated.

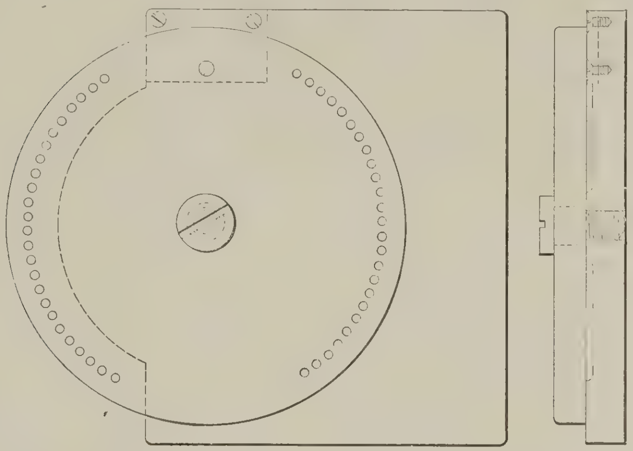
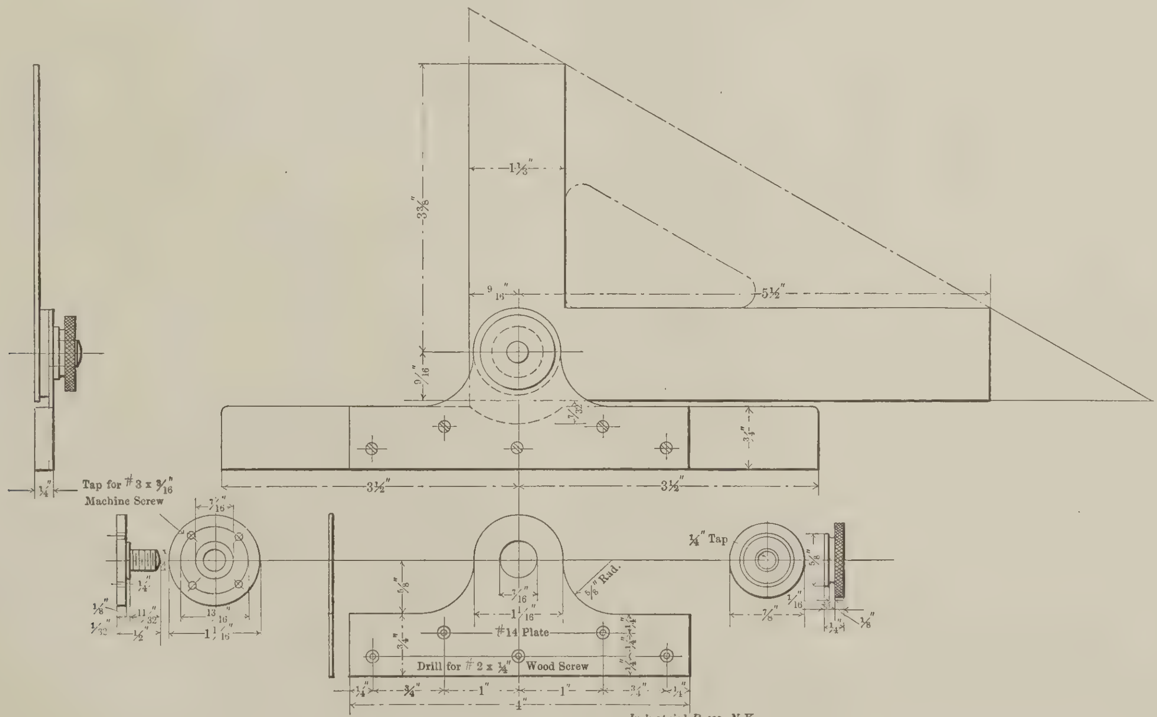


Fig. 8

Fig. 8. Plate for Grinding off Ends of Springs.

It was not long until the boy doing the work let the lathe run until the sleeve was forced off the end of the mandrel, with the result that the wire was twisted off, leaving the end still threaded through the hole in the sleeve. He was bright enough to see that this was an improvement over stopping the lathe, cutting the wire, winding the end and then threading up again, and the job was finished by twisting off, and afterward similar ones were done in the same manner.



Draftsman's Adjustable Angle.

To cut the springs to length a simple shearing fixture was made, which is shown in Fig. 6. The end of one of the long wound lengths was passed through the hardened steel bushing until the end touched the gage, when a quick stroke of the lever cut it off the supposed proper length.

The writer tested this fixture and found that the springs could be cut with only a small variation in length. But what can be done, and what a boy left to his own devices for a little while will do, are often radically different propositions.

We delivered a few of these springs for trial and our customer discovered that the end of the wire upon which the pin rested caught on the sides of the hole and created a lot of friction, and decided that it would be necessary to bend in the end of the spring to overcome this difficulty. This did not look like a desirable job and after experimenting with it I concluded that it was worse than it looked.

Of course it was an extra and I put on a price that I thought would keep it away. However it did not, so I took several pairs of small pliers and had them fixed as shown in Fig. 7. I tried three boys on the job with very poor success. Two of them either could not or would not do the work properly, and the third at the end of the first day threatened to leave. I finally had them done outside the shop by piecework.

Before I was out of the above trouble, complaint came in that there was too much variation in the lengths of the springs. I might mention that this was the first lot of these machines and as is usual the customer was constantly finding out things about them. The proprietor of our shop got disgusted and threatened to tell him that if they were not good enough he would have to fix them himself. But he did not and we had to find a way out. I concluded to try grinding and as a test took a piece of hardwood 13-32 inch thick and drilled a hole through it large enough to receive a spring. Taking this to the surface grinder I set the table at the proper height, dropped a spring in the hole and slid the board carefully under the wheel. I tried a dozen or more and found that I could get them the same length within a few thousandths of an inch. Then I had the fixture shown in Fig. 8 made. It will be noted that there are two sets of holes, 25 in each set. The fixture was clamped to the table of the grinder, one set of holes filled with springs and the disk turned slowly so as to bring them in succession under the emery wheel. After passing the wheel they dropped into a box and the boy by keeping an account of the number of sets had them counted.

In a short time complaint came that the springs were too long, and investigation showed that the cast-iron plate beneath the wheel had been worn by the sharp ends of the wire. A hardened steel plate at this point cured this difficulty. The grinder was in the tool room, so I had the boy in charge do the grinding, as he had lots of spare time. At first he turned out a goodly number but soon the output began to fall off, so finally I tried the premium plan on him. He was not long in discovering that he could increase his wages fifty per cent. and the job did not last long after that.

WAITE J. BEVERTS.

DRAFTSMAN'S SPECIAL ANGLE.

Editor MACHINERY:

Most draftsmen are fully aware of the trouble of making drawings on the skew. While this may be done by shifting the straight-edge or using one triangle against another, it is tiresome to do so and, where there is much such work to do, the special angle shown in the cut on the preceding page, will be found a very convenient tool to use, as it can be set at any angle to suit the work.

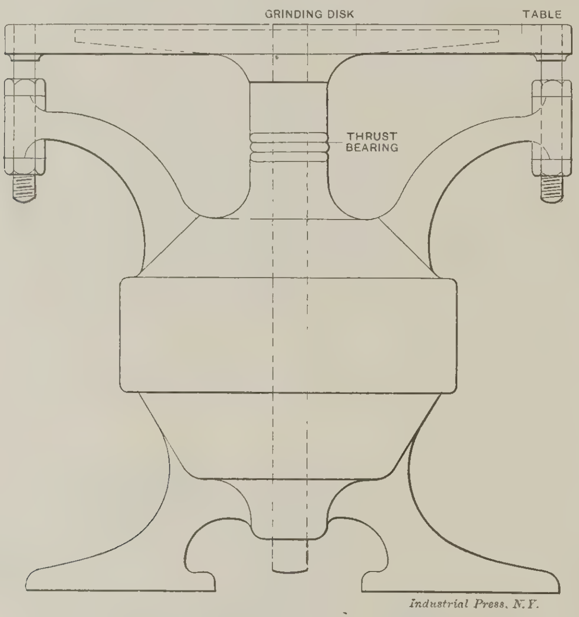
The blade was made out of an old 30 by 60-degree triangle, as the cut shows, and is fastened to the clamping screw by four No. 3 x ¼-inch machine screws with heads countersunk into the blade. The remainder of the cut explains itself.

Shelby, O. W. HOY BRADLEY.

GRINDER FOR CONTROLLER CONTACTS—SCREW DRIVERS FOR BRASS WORK.

Editor MACHINERY:

Herewith is given a description and sketch, Fig. 1, of a method of finishing the contact parts on electrical controlling apparatus. It is a combination of an electric motor having a grinding disk mounted directly on the vertical armature shaft and having a table arranged to support the slate or marble slabs to which the contacts are fastened by flat head screws and nuts.

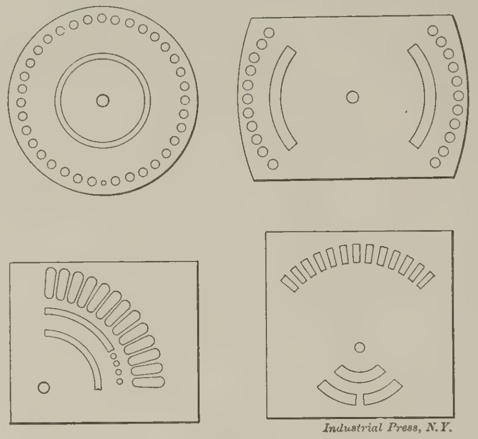


Industrial Press, N.Y.

Fig. 1. Sprague Motor Converted into Vertical Grinder.

The changes necessary to convert an ordinary Sprague motor to a vertical motor were very simple, the casting holding the field coils being retained in its original form. The castings supporting both ends of the armature shaft were so altered as to allow the motor to stand upright and also provide means of holding a table. This is clearly shown in the drawing, making a detailed description unnecessary. The table itself was held at the proper height in relation to the grinding disk by four studs and nuts, as shown. While this is undoubtedly a crude method of adjusting the table, still it was adopted because the quantity of one kind of work done on this machine required that the table remain in one position for quite some time. It was found quite necessary to counteract the excessive downward thrust of the shaft (occasioned by the weight of the armature winding and the pressure on the disk) by means of a ball and roller bearing on the shaft directly under the disk. Besides a considerable saving of time over the milling machine this grinder has the additional advantage of giving the contacts the finished appearance which is very desirable in work of this kind. Fig. 2 shows some samples of the work done.

The sketch, Fig. 3, relating to the screw drivers probably explains itself. Where a large number of finished brass screws are to be driven it is necessary to use a screwdriver that will *fit* the slot in the head. Finding that the common driver with its blade shaped like a cold-chisel, *A*, would not answer the requirements at all because of the tendency to slip and mar the head of the screw the style of blade shown at *B* was devised. It is simply a piece of drill rod ground on an emery wheel to fit the slot, as shown. This makes a very practical tool, which, when worn or broken may be easily repaired by the same method by which it was originally made. The driver for round head screws shown at *C* is made with an inserted blade and the stock is hollowed out to fit the head.



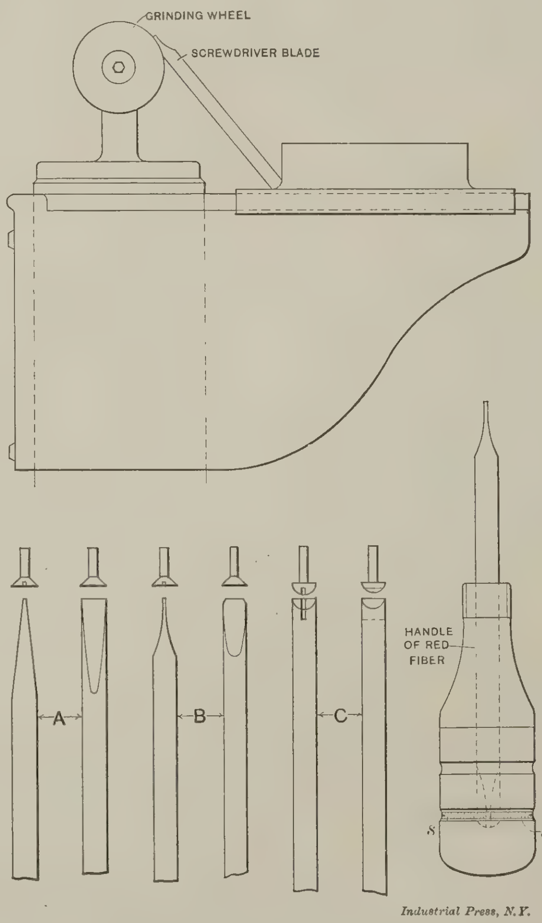
Industrial Press, N.Y.

Fig. 2. Samples of Work Done.

After quite a bit of experimenting the handle of red fiber was adopted for all drivers because of its simplicity. It can be made a nice fit on the drill rod and the two small screws, *ss'*, that bear on the flats of the blade prevent same from turning when strain is applied. These details may seem trivial to most shops, but where there are about fifty screw drivers in use day after day the necessity for some system becomes evident.

H. J. BACHMANN.

New York.



Industrial Press, N.Y.

Fig. 3. Construction of Screw Drivers.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

CUTTING SLOTS WITH A HACK SAW—SAWING TUBING.

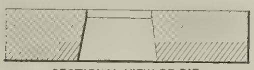
We recently had to cut a number of slots 1-16 inch wide in a position where they could not be milled. We first tried to cut them with a hack-saw and then file them out, but found this process too slow. By putting two blades in the saw frame at once, however, I sawed the slots without any trouble. The set of the teeth in one blade came just right to let the blades lie close together.

If you have to saw thin tubing or anything of a similar nature, grind the set off of one side of two blades, and place them in the frame with the teeth pointing in opposite directions. You will be surprised at the result.

Cincinnati, O. J. L. MARSHALL.

WAY TO GRIND SHEAR ON CUTTING DIES.

It is a well-known fact that shearing a die makes the punching operation much easier on the press. Very often, however, it is found advantageous to leave the die straight until after hardening. The object of this sketch is to show a simple and effective method of grinding the shear after the die is hardened on a common grindstone.



SECTIONAL VIEW OF DIE BEFORE GRINDING
FIG. 1

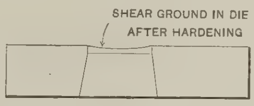


FIG. 2

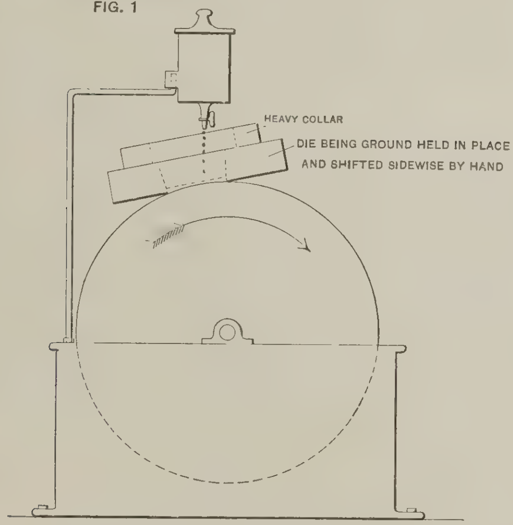


FIG. 3 *Industrial Press, N.Y.*

Figs. 1 and 2 show the die before and after grinding. Fig. 3 shows the die in position near the top of grindstone with a heavy collar on same, the latter being added to impart sufficient pressure. The water falls into the opening in the die, and all that the operator has to do is to keep the die slightly to the back of the center, so it has a tendency to climb, which fact makes it very easy holding, as it would naturally be difficult to hold the die in place at the extreme top of grindstone. Shifting the die sidewise causes the grinding action to be more effective, it is needless to say. While this is a rather odd way to do the "trick," yet it is certainly O. K., inasmuch as it is not only easy, but is also safe, there being no chance to draw the temper, which is liable to be the case in using an emery wheel. ROBERT A. LACHMANN.

Chicago, Ill.

DRILLING HARDENED STEEL.

I saw in the March number how F. J. K. drilled his saws, and perhaps it was about the best thing to do in that particular case. I had a similar experience some time ago on some spring shifters. We were building a machine and the spring for the shifters was ordered of spring steel stock ¼ by 1 inch. There were twelve of the shifters which were bent by the blacksmith to the desired shape, and two holes had to be drilled in each one. They were found to be too hard to drill after being bent and so were annealed at the end where the holes were to be drilled; but the annealing did not make them soft enough for drilling and I had to grind drill two or three times for each hole, although turpentine was used for lubricant. Then I re-ground the drill, making it very flat so that the point was only about 1-64 inch ahead of the cutting edges. With this form of grinding and by using coal oil (kerosene) I was able to drill the remaining 22 holes with only two grindings of the drill.

After testing the steel we found it to be a refined tool steel plenty good enough for chisels. In fact I had a ⅜-inch chisel made from the steel, and it stood up well. For drilling hardened steel and chilled cast iron I think there is nothing like coal oil. We use Morse twist drills.

Hanover, Pa. COOK DUNKINSON.

BABBITT SOCKETS FOR RATCHET DRILLS.

I had to drill a number of holes of different sizes with the ratchet drill but found, when I got the ratchet and what drills there were from the tool room, that the ratchet had a square taper hole in the spindle, and that there was no way of holding the regular taper or straight-shank drills.

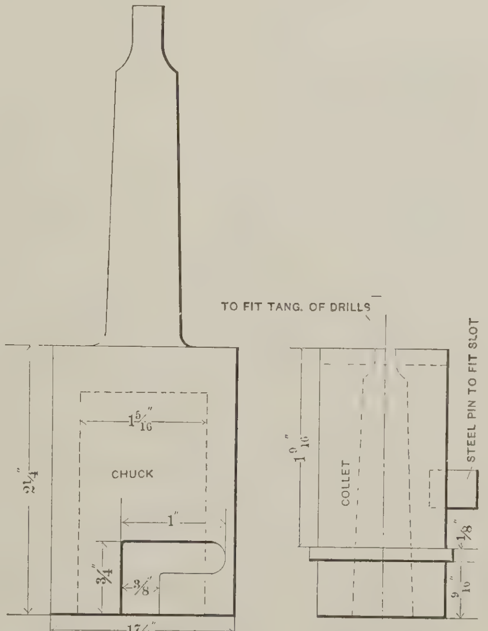
It seemed as though I should have to make some flat drills for the job, when the idea occurred to me to make a babbitt socket for each drill, excepting of course those whose shanks were the same size. It did not take long to get the ladle on the fire, and while the babbitt was heating I put a plug, with a spot in the center of it, to locate drill in the hole, to keep the babbitt away from the screw, and a little putty around the top. A piece of flat steel was held in the vise with the ratchet, so that when the drill was lined up with the spindle we could see how near to hold the point to the strip of steel when pouring.

On the straight-shank drills I filed a flat on opposite sides at the end to keep it from slipping in the socket. One of the boys held the drill while I poured in the babbitt. The sockets filled the bill to a "Tee" and can be used again when wanted.

Cleveland, O. CARL HOLMGREN.

DRILL CHUCK WITH BAYONET LOCK.

The sketches show a drill chuck that I made some time ago for an air drill, and afterwards made for our drill presses. I found there was always trouble when the collets were driven out; now we can leave the chuck always in the drill spindle, and remove the collets with the drills by simply turning them backwards a short distance to disengage the pin from the slot. G. I. B.

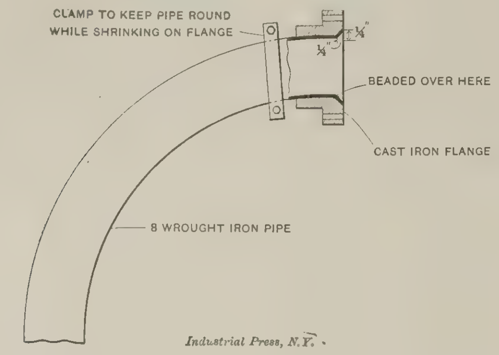


Industrial Press, N.Y.

SHRINKING A FLANGE ON AN EIGHT-INCH PIPE.

We recently installed a new vertical boiler in our plant, and when we came to put up the 8-inch steam pipe it was found that the U-bend which connected with the top of the boiler was about 6 inches too long. The cast iron flanges were screwed on, and to cut a thread was out of the question. We unscrewed one flange and, after cutting the pipe off with the hack saw, we put a clamp on the pipe about 4 inches from the sawed-off end and screwed up till the pipe calipered nearly round. The scale was filed off the outside for about 2 inches back from the end. The flange was bored out 1-64 inch small, and chamfered on the face end ¼ inch back. After shrinking on, the pipe was beaded around while hot. Before putting the pipe on the boiler it was tested to 400 pounds square inches water pressure, and it never sweat a drop. Needless to add that after turning on the 160 pounds steam no calking was necessary. **Geo. R. Lang.**

Cincinnati, Ohio.



Industrial Press, N.Y.

CASEHARDENING WORK IN PART.

It sometimes happens that only certain parts of a piece are wanted hardened; it may be because these are to resist wear while it is desired to drill or further machine certain features. In such cases it is convenient to be able to caseharden just so much of the piece as may be desired. The trick of doing this was well known years ago, but has passed out of memory pretty generally until the bicycle business developed so enormously a few years ago, when it was revived in connection with the manufacture of parts.

The trick is very simple and can be readily done in almost any shop. It is only necessary to cover the spots or places which it is wished to keep soft, with a thin coating of copper. Carbon does not penetrate copper, and, as the process of casehardening is only one of carbonizing the surface of iron, it follows that a deposit of copper will preserve the part under it from the hardening effect.

A good way to apply the copper is by means of the electrolytic bath. A bath of copper sulphate (blue vitriol) is prepared, in which the piece to be treated is suspended from the negative pole of an electric battery, opposite a sheet of copper suspended from the positive pole. After a sufficient thickness has been deposited the copper may be buffed from the parts which are to be hardened; or, as is usually more convenient, the part to be hardened is coated with wax or some easily removed varnish, and then placed in the bath, the wax or varnish being afterward removed by heating or otherwise. No copper will be deposited except where the metal was exposed to the action of the bath.

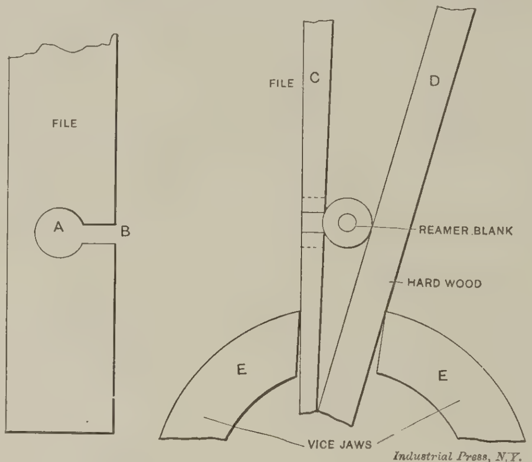
O. M. B.

[Another method of casehardening a piece in part, that is used considerably in locomotive works, is to use the bone pack as usual but not to plunge the piece into cold water when dumping it from the box. Instead it is left to cool off, and then the parts that are to be left soft are machined to remove the carbonized skin. A rocker pin, for instance, will be roughed out on all parts save the bearing in the link-block, which will be turned to size with the allowance for grinding. The pin is then "packed" as usual, and carbonized, but as already stated, it is not hardened first off. The taper fit in the rocker arm is turned, the thread cut on the end and the head is finished. When the pin is again heated and dipped, only the bearing in the link-block hardens since the carbonized skin was removed from all other portions.—Editor.]

OLD METHOD OF MAKING SPHERICAL ROSE REAMERS.

While in conversation with an old gunsmith recently the subject of making tools came up, and I asked him how he made the rose reamers used in making bullet molds. He said the process was very simple, and described it as follows:

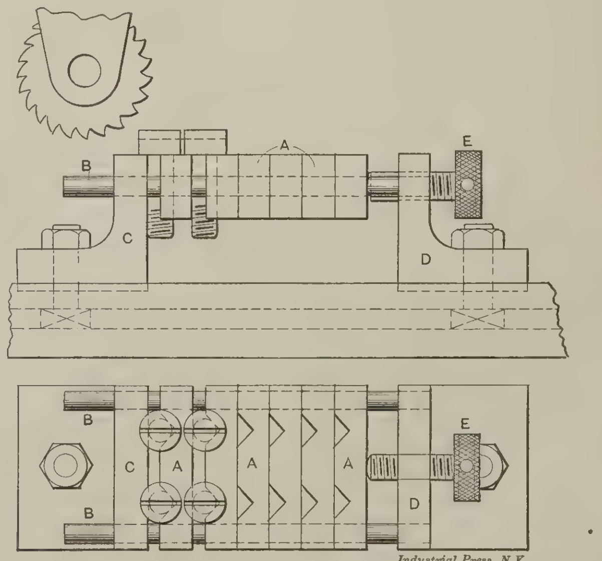
First take an old flat file, 10 or 12-inch, soften it, grind or file off the teeth on one side and edge, and then drill a hole as at *A* of the size of the reamer desired. File a slot *B* the thickness of the reamer neck, then harden and temper the file. After turning the reamer as nearly to size as can be accomplished easily, place it with the file *C* and a piece of hard wood *D* in a vise with the reamer blank as indicated. Turn the reamer blank steadily with a bit-brace or other convenient means, and very soon you will have a blank reamer truly round. The spring of the wooden piece *D* will force the blank as it is turned through the hole in the file, the edges of the hole in file cutting away the metal. The reamer teeth are then filed in with the proper shape files, and then tempered. **F. H. Jackson.**



Industrial Press, N.Y.

JIG FOR SLOTTING SCREW HEADS.

A correspondent describes in the *Mechanical World* a simple and apparently excellent jig for holding screws for slotting the heads. It has the great advantage of holding each screw with the same grip, no matter if the diameters are not uniform. It consists of the angle plates *C* and *D*, both having tongues underneath to fit the slot in the milling machine table, and in *D* is fitted the binding screw *E* and the guides *B*, which latter are securely fixed. The guides carry the V-blocks *A*, between which the screws are clamped. The guides slide freely through the holes in the angle plate *C* and may be made whatever length desired to accommodate the number of V-blocks and screws. If the full capacity of the jig is not required, say only four screws are to be slotted, as shown in the cut, the angle plate *C* is moved toward *D* so that the binding screw *E* shall be long enough to clamp the screws. In fact the arrangement is a most flexible one, and should prove a very satisfactory rig for the average shop.



Industrial Press, N.Y.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

40. A. L. G.—In the description of the Bullock shop in the February, 1904, issue, you say the boring-mill device or attachment for boring spherical seats can be used to generate cycloid curves. How is this done?

A.—By feeding the bar on the fixed slide downward at one-half the rate of the bar on the movable slide the tool in the latter bar will be made to travel in a cycloid curve.

41. "Solder."—Is there a process of soldering without heat, and, if so, what is it?

A.—A so-called soldering process without heat is given, but we cannot vouch for its efficiency. To 1 ounce of hydrofluoric acid add 8 ounces of brass filings and 8 ounces of steel filings (or proportional amounts). Apply to the parts and clamp together for some hours. Hydrofluoric acid must be handled with great care and must be kept in lead bottles as it dissolves glass.

42. A. L. P.—How is the coppering done such as is seen on cast iron toys, etc.? Is it done by electroplating?

A.—For a specific answer we refer the question to the readers. The process is not that of electroplating, but is done by dipping the parts into a bath of melted copper. The parts are heated to a high temperature, and the melted copper is said to be covered with a layer of cryolite and phosphoric acid to act as a flux and prevent oxidation. Perhaps a little experimenting will enable you to do the work successfully.

43. X. Y.—What is the best way of starting and stopping a dynamo that is connected to the main shaft?

Answered by Wm. Baxter, Jr.

A.—The best way of starting and stopping a dynamo, whether belt driven or direct connected, is to set it in motion with the main switch open, and open the main switch before stopping. In starting, after the machine has run up to full speed, see that the voltage is up to the proper point, and if it is not, adjust the field regulator until it is. When the voltage is at the proper point, close the main switch and then throw the load on gradually by closing the switches that connect the motors, lamps, etc., supplied by the generator. In stopping, the main switch should be opened first, so as to obviate the liability of starting up again with the main circuit closed. As a rule, no harm is done when a single generator is in use, if it is started with the main switch closed, but if the circuit happened to be short-circuited some damage might be done.

44. C. L.—1. Kindly state how to make formed milling cutters and circular forming tools of broad face, say from 1 inch face up. Does it need an extra stiff lathe, and are they made with a master tool of the full length of the face? I am troubled by the tool digging in, leaving a ridge. 2. How are the shear blades of large squaring shears, say 10 inches long, hardened without excessive springing?

A.—Formed milling cutters and circular forming tools may be finished either with a master forming tool, or else (as a makeshift) by the use of several radius or other forming tools, by which the piece can be shaped to fit a templet. A forming tool is used to remove only a small quantity of stock, after the piece has been brought to nearly the proper shape with an ordinary lathe tool. If you attempt to take much of a cut with a forming tool you will be sure to meet with the trouble mentioned. Another thing that is absolutely essential is to have both lathe and work as solid and rigid as possible. Still a third principle is to give the forming tool more clearance than is customary with a lathe tool. This is illustrated, in an exaggerated manner, in the sketch herewith. In Fig. 1 is shown a lathe tool. This is ground with top rake, and therefore only a small amount of clearance is necessary to give a cutting point. In Fig. 2 is a forming tool, which can have no top rake because, in order to retain their shape, such tools should have a flat top face which can be set horizontally on a line with the center of the work. In order to cut satisfactorily, therefore, the sharp cutting edge must be produced by giving more clearance underneath, as shown at *a*.

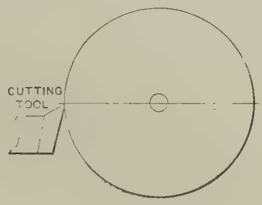


Fig. 1

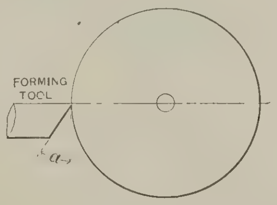


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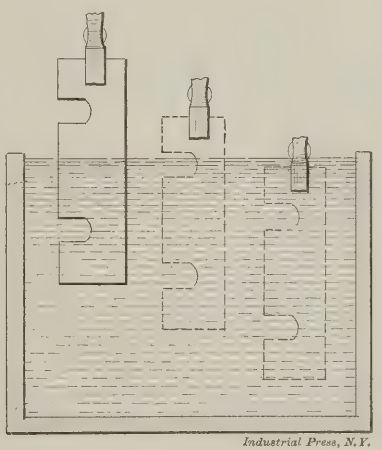
Fig. 2.

The second question is answered as follows by Mr. E. R. Markham:

2. As a rule the hardening of this class of work is attended with more or less trouble when attempted in the shop not specially fitted for it; yet if care is exercised and a method used which is adapted to the character of the piece the trouble from springing may be materially reduced in most cases. If the blade is made from a comparatively high carbon steel the tendency to spring will be greater than if a low carbon steel is used; but the blade will last a great deal longer, the higher carbon steel making much the best blade. If possible, rough-plane the blade and cut the screw slots shown in Fig. 3 nearly to size before annealing, to remove the internal strains as far as possible before the operation of hardening. When heating for hardening, place the blade in a hardening box and heat in a furnace, if one is at hand. In this manner a uniform heat may be attained. But if obliged to heat in a forge of the ordinary type, build a large, high fire, so as to have as nearly as possible a uniform heat. The edges and corners should be no hotter than the balance of the piece or the uneven heat will cause them to crack, from uneven contraction when plunged in the bath.

Fig. 3.



Industrial Press, N.Y.

Fig. 4.

The bath used should be brine which is of a temperature of about 60 degrees F. Grasp the blade by one end with a suitable pair of tongs, dipping it in the bath in a vertical position, as shown in Fig. 4. It should be lowered slowly into the bath and moved edgewise while being lowered, as shown by dotted lines. This brings the cutting edge in contact with the fresh, cool contents of the bath and allows the steam which is generated to pass from this edge to the one containing the slots. This action of the steam leaves the cutting edge so it can be freely acted upon by the bath and the steam forming a cushion at the other edge prevents that from hardening as rapidly as it otherwise would, thus preventing springing, or at least reducing the tendency to the minimum. Moving the blade in the bath as described has the same effect as when a "half round" reamer is dipped in the hardening bath on an angle, the heavier portion being down and subjected first to the action of the bath. In the case of the blade it is moved along in the bath, the cutting edge being kept in contact with the bath and free from steam. Be very careful that the flat sides are exposed evenly to the liquid, or excessive springing in one direction or the other will result.

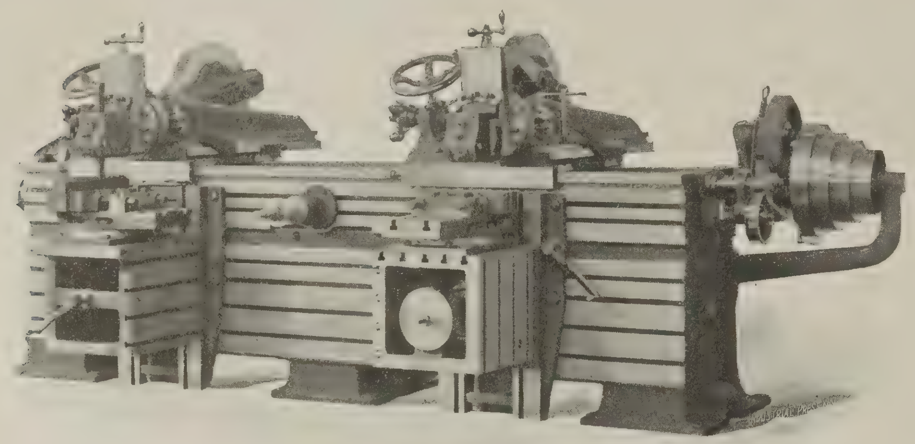
There are other methods but most of them require special apparatus and consequently are of little value in the ordinary shop.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

TRAVERSE SHAPER WITH PULL-CUT HEAD.

The machine illustrated herewith, built by the Cincinnati Shaper Co., Cincinnati, O., differs from the ordinary type of traverse shaper in that the cutting tools are reversed, the cutting taking place during the backward motion of the ram and the quick return during the forward motion. With the exception of the head, the ram and a few other modifications that have been deemed necessary, it is similar to the ordinary push-cut shaper manufactured by this firm. The construction of the head is such as to make it rigid and strong, to resist any tendency to yield or spring under cutting strain. The strain comes directly upon solid metal and not upon threads, bolts or screw points, except in the case of the setscrews that hold the tool, which, however, are large in diameter and have a long bearing.



New Draw-cut Shaper.

The special features of the machine are that the pressure or thrust of the tool is taken directly back against the bed and tends to draw the table and apron more closely to the bed rather than to force them apart. This the builders inform us is a decided advantage, especially when heavy cutting is being done, as is the case when using high-speed steels. In many cases, too, the work can be pressed directly against the bed, so that resistance to the cutting is not altogether dependent upon the hard clamping of work and table. Large pieces can also be bolted directly to the bed, the tables being removed—a distinct advantage in certain classes of work.

EIGHT-INCH PIPE-THREADING MACHINE.

In the design of this machine, the product of the Stoever Foundry & Mfg. Co., Myerstown, Pa., careful attention has been paid to the strength of the working parts, as it is subjected to very severe strains and usually operated by unskilled labor. The headstock is a single casting, insuring rigidity and also permanent alignment of all the bearings. The bed, as will be seen in the half-tone, is very heavy and well braced.

The capacity of the machine is from 2½ to 8 inches, inclusive, a separate set of dies for each size of pipe. There are therefore nine sizes of pipe that it will cut, and the machine has been designed with one speed for each size of pipe. Most machines have but six speeds for the nine pipe sizes. The nine speeds are obtained through a gear box having five separate speeds, and a double clutch on one of the shafts throwing between two trains of gears having different ratios. The clutch is an improvement over the sliding gears commonly used, as it will throw over at any point, whereas the gears will slide into mesh at only a few points.

The chucks are of the 3-jaw independent type, both front and rear chucks being provided with jaws for gripping the pipe. The faces of the slides are graduated, facilitating the setting of them to any particular size of pipe. Special grips for holding flanges or flanged fittings are placed on the slides of the rear chuck, by use of which the fittings can be made up on the pipe much more quickly than by hand, and with a much tighter joint.

By the use of a single driving pulley a constant belt speed is obtained, which is designed for the maximum work. The machine can be placed either in line with, or at right angles to, the countershaft, and a motor can be attached in the simplest manner. The gear box mechanism is operated by two levers and consists simply of a cone of gears on one shaft and a sliding pinion connected with the driving shaft, which pinion can be brought to mesh with any of the cone gears. The case is oil tight, and a small amount of oil will keep the gears lubricated for a long time.

The use of an internal driving gear is another feature, and adds to the appearance of the machine, as well as to its safety. This design also brings the gears close to the body of the machine. All the gearing can be quickly removed without disturbing the other parts—an important point when possible accidents are considered.

The die head is of improved construction. The cams are of steel, hardened and inserted in the ring. They are interchangeable in the same ring, and, when necessary, can be replaced at a very small cost. This prevents the dies from losing their gage through wear of cams. The bottoms of the slots in which the chasers travel are formed by hardened steel plates, as a precaution against their getting out of lead. The adjusting mechanism is an improved arrangement of the levers by which the hand nut on the adjusting screw is placed directly in front of the operator. When the handle is pushed downward the lever rests on the screw, as shown in Fig. 2, which results in bringing the screw and the lever in a straight line, regardless of the extent of the adjustment. When in this position the dies are fully closed and any upward movement of the lever will release the thread without causing the dies

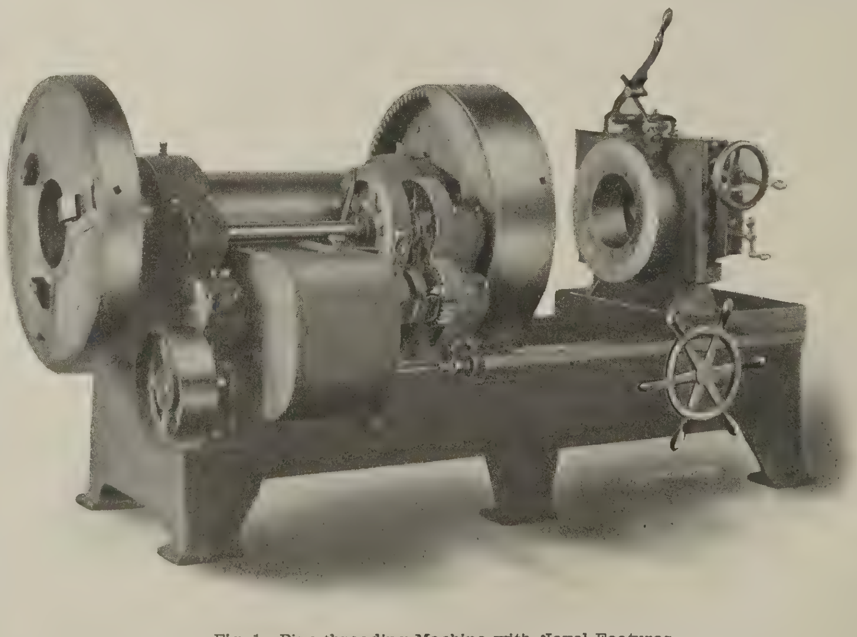


Fig. 1. Pipe-threading Machine with Novel Features.

to dig into the work—a fault that is sometimes experienced with this type of mechanism.

The cam ring shown in Fig. 3 is from a 12-inch machine, but the construction is the same in all sizes, the difference being that the 8-inch ring has 7 cams and the 12-inch ring 9 cams. The cams are made from forgings and hardened after finishing, making them practically indestructible. They are held in the ring by bevel keys which are held by fillister head screws through the outside of the ring. These keys draw the cams tight against the body of the ring and they cannot possibly get away.

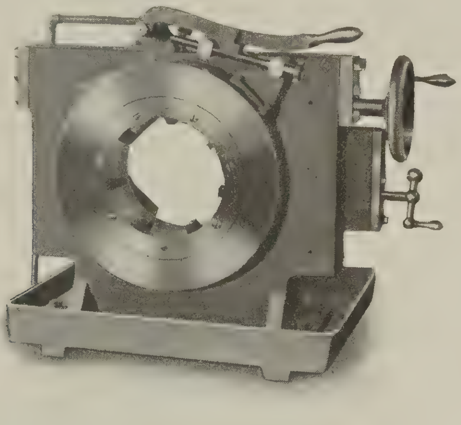


Fig 2. Adjusting Mechanism, Stoever Foundry & Mfg. Co.

The dies are removed from the head through the center when the head is expanded to its extreme limit. To prevent the upper dies from falling out spring pins are placed in the ends of the upper cams, these pins engaging the slots in the dies as they disengage from the adjoining cam. A slight pull on the die will release it from the pin.

The machines are now being built in the following sizes: No. 4, capacity 1 to 4 inches; No. 8, capacity 2½ to 8 inches; and No. 12, capacity 4 to 12 inches.

BLUEPRINTING MACHINE.

A vertical cylindrical blueprinting apparatus in which the electric arc is used in place of sunlight is now manufactured by the Keuffel & Esser Co., 127 Fulton Street, New York, the well-known manufacturers and dealers in draftsmen's supplies. This apparatus consists of two sections of curved glass, each mounted in a metal casing and together forming a cylinder which rotates on a circular base. The lamp is suspended in the axial line of the cylinder, where it travels by clockwork or by an electric motor.

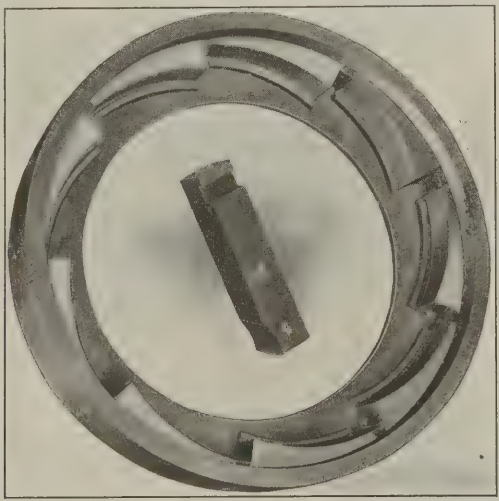


Fig. 3. Cam Ring and one of the Chasers, Stoever Foundry & Mfg. Co.

Tracing and paper are placed on the outer surface of the glass cylinder, where they are held by a canvas curtain mounted on a vertical roller attached to the upright which carries also the lamp and the mechanism for moving it. This curtain is wound on to the cylinder by rotating the cylinder on its base, which is done by a conveniently placed hand wheel. It is held tense by the roller spring and a foot brake on the base plate, which arrests the cylinder. The rotating of the cylinder therefore automatically winds the curtain onto it and holds the tracings and paper in very good contact. The feeding in of the tracing and paper is easily and quickly accomplished, and there is no tilting of the glass cylinder. The unwinding of the curtain is done by means of the hand wheel, assisted by the spring acting on the curtain roller.

The lamp is of a special pattern, to diffuse the light, and the current is cut off automatically at the end of the travel of the lamp.

SEMI-RADIAL DRILL.

The machine illustrated below, recently brought out by the Bickford Drill & Tool Co., Cincinnati, O., has a high ratio of transmission gears and this combined with the simplicity of design and rigid construction makes it well adapted for many classes of work. The frame consists of but five parts; the base, column, cap, arm and arm shaft, each of which is proportioned for the continuous severe work expected of the machine. The head is a single casting, and is adjustable on the arm by means of a spiral gear, which gives it a quick easy motion. All bearings on the head are of uncommon length. The spindle, of hammered steel and unusual vertical adjustment, is provided with both hand and power feed, and quick advance and return.

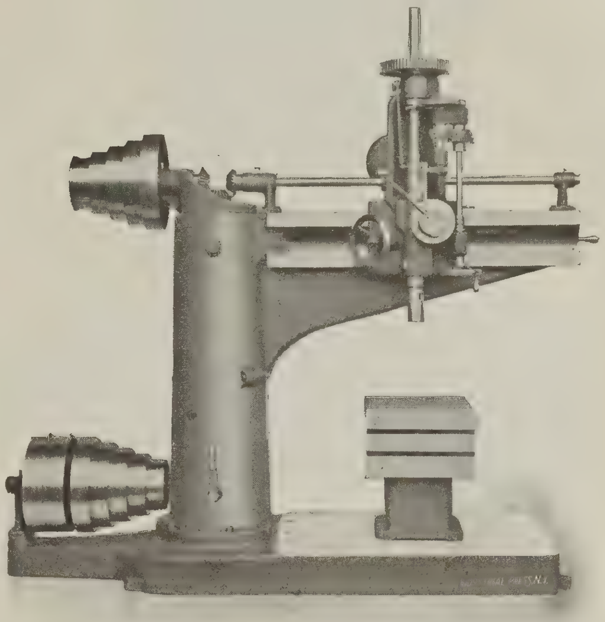
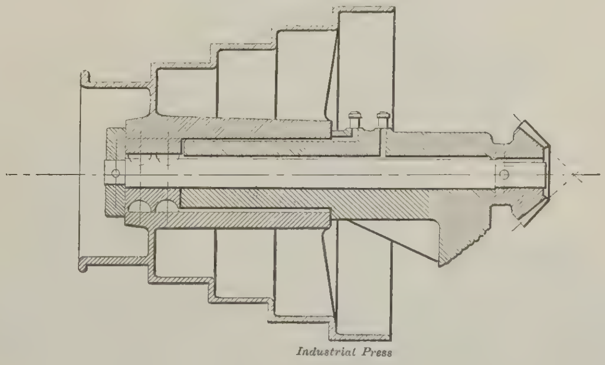


Fig. 1. Bickford Semi-radial Drill.



Industrial Press

Fig. 2. Detail of Upper Cone Bearing.

The feeding mechanism furnishes three rates of feed, advancing by even increments from .008 inch to .016 inch per revolution of spindle, each of which is instantly available by means of the Bickford standard drive key.

The driving mechanism contains but seven gears, the pitch and periphery speed of which are conducive to long life. The speeds are five in number and advance in geometrical progression from 50 to 170 revolutions per minute. The spindle has a traverse of 18 inches and the head a range of 3 feet 6¾ inches. The spindle will take work 24 inches high over the table and 4 feet high over the bedplate. It will drill work in plane of base to center of 8 feet; the width of the cone belt is 3 inches and the countershaft runs at 300 revolutions per minute. The net weight of the machine is 6,500 pounds.

METAL-WORKING PRESS.

The illustration herewith of a new press built by the Perkins Machine Co., now of Warren, Mass., formerly of Boston, Mass., shows a machine designed for the use of automobile manufacturers for trimming their crankshaft forgings, etc. The press weighs 17,300 pounds and is exceptionally heavy and powerful to withstand the strains of the severe duty to which it is subjected in this class of work. The shaft is of selected acid steel of the new process, which is believed to be the best that can be used for the purpose. Although the plunger is very heavy it can be adjusted by one man with little effort. The clutch on this press is of the regular Perkins type, instantaneous in its action and giving a positive drive. The press is self-contained, no foundation being necessary. The weight of the shaft and gear is taken care of by an outboard bearing. The large gear is 6 feet in diameter, with cut teeth. The press is provided with an attachment at the side which cuts the forgings off after being trimmed.

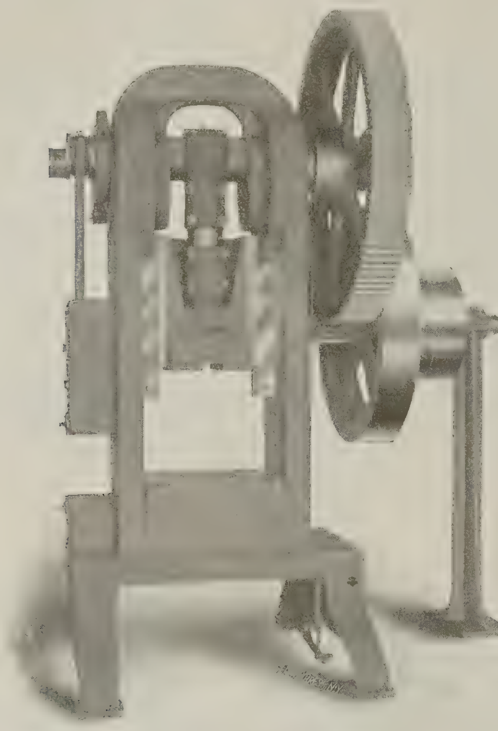

Trimming Press for Heavy Work.

PLATE STRAIGHTENING ROLL.

The straightening roll here illustrated has seven rolls, four in the upper series and three in the lower. Each roll in the upper series is arranged for either independent or universal adjustment, by means of steel worms and steel screws, which can be done accurately by means of indicators. Either end of any of the top rolls can be adjusted independently by removing the cap over the adjusting screw controlling same. This obviates the necessity of having four or five handwheels placed on different sides of the machine; hence it is operated entirely from one end. The top rolls can be raised high enough for all standard work; but for special work provision can easily be made for raising them any required distance from the bottom roll. The second top roll is placed slightly forward and acts as a pinch roll, which facilitates feeding the plates, and also causes it to exert a compressing and stretching pressure. The front and rear top rolls are smaller than the principal rolls, as they perform comparatively light duty; hence, they are placed closer to the adjacent rolls than they could be if larger, and are therefore more effective on the outer surface of the plates, especially on light plates. The machine is also arranged for curving or bending, the same as a regular bending roll, and it is also built with either eight or nine rolls, if desired.

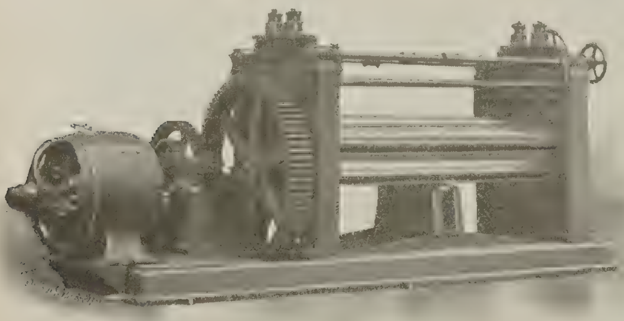
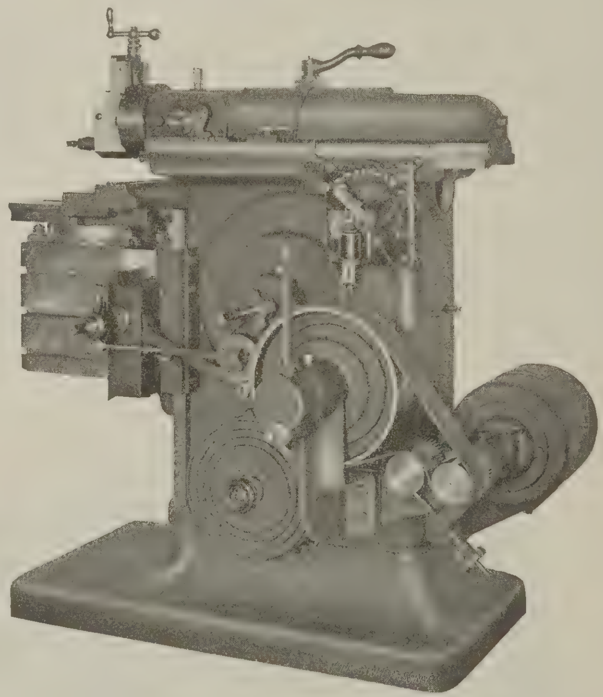


Plate Straightening Roll.

The housings and gears are amply strong, and the pinions are made of cast steel. It has a heavy base plate, supporting a roller center-bearing for the lower rolls. The entire machine is self contained. It is provided with motor, engine or belt drive, and is made any size for plates from ⅛ inch to 1½ inch thick. It is built by Bertsch & Co., Cambridge City, Ind.

SHAPER WITH NEW STYLE OF DRIVE.

A 16-inch shaper, manufactured by the Stockbridge Machine Co., Worcester, Mass., is shown in the accompanying illustration, with an electric motor attachment which presents something new in the way of a belt drive. This style of machine is built in three sizes: the 16-inch size, shown, and the 20 and 24-inch.


"Stockbridge" 16-inch Shaper.

It will be noted that the driver and idler pulleys are geared together, so that both drive the belt positively, and that by means of the adjustment any degree of tension can be put upon the belt. The idler is hung on a bell-crank lever which can be swung around until the belt has an arc of contact on the driving pulley almost equal to the full circumference of the pulley. This drive has proven, under practical tests, to be as positive as a chain drive which has the advantage of a slight flexibility of the belt. As far as we know this is a new idea in belt drives, and, like other things, is so simple yet effectual that it will probably be wondered why it was never thought of before.

TWO DRILLS ADAPTED FOR SPECIAL WORK.

Baker Bros., Toledo, O., have sent us photographs of two of their heavy drills adapted for the production of miter gears and automobile sprockets.

Fig. 1 shows their "K" machine for the production of 15½-inch steel casting automobile sprockets. Owing to their being notched and very thin it is difficult to turn these sprockets in a lathe and only from six to ten sprockets can be so turned in nine hours' time; but with the drill made by this company 65 sprockets have been produced in that time. This is accomplished by the use of a forming cutter that is set with a shearing cut. The casting is drilled with six holes to a jig, which corresponds to a fixture attached to the table of the drill having six projecting pins that exactly fit these holes. The casting is placed over these pins and the head, with forming cutters, is brought down on same, facing one side and reducing it to the proper diameter. The casting is then turned over and finished on the other side in a similar manner. The work is turned out within a limit of .003 of an inch.

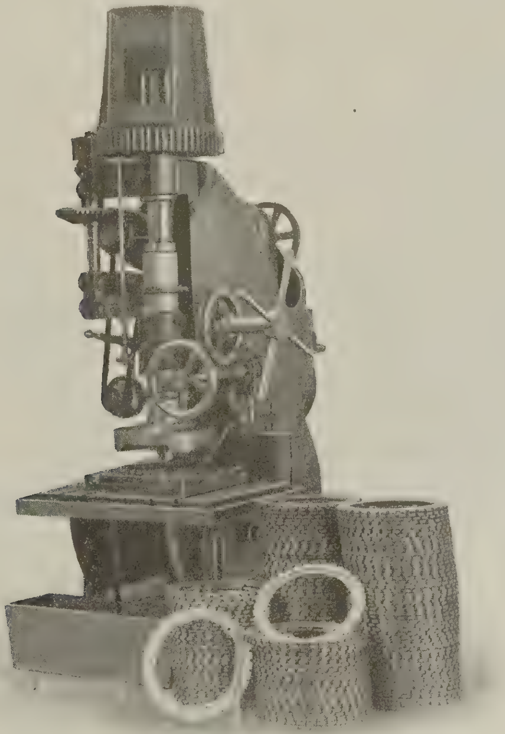


Fig. 1. Style "K" Drill, Baker Bros.

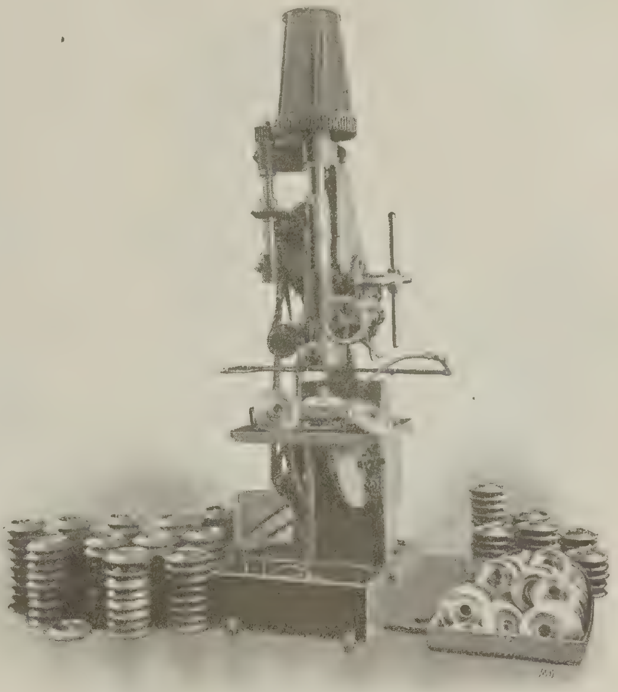


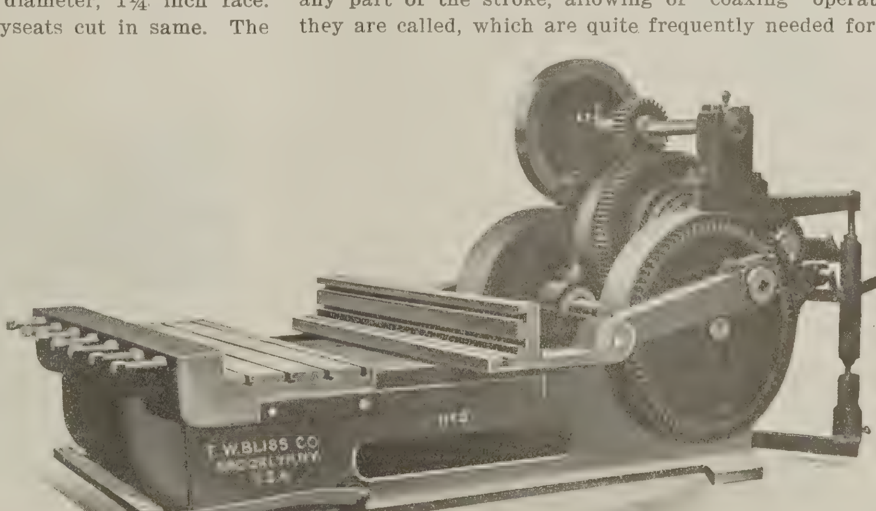
Fig. 2. Style "M" Drill, Baker Bros.

Fig. 2 shows their "Style M" drill working on miter gears of drop-forged steel, 8½ inches in diameter, 1¼ inch face. The blank is first bored and two keyseats cut in same. The hole and keyseats just fit an arbor and fixture that are securely fastened to the drill table. The keys act as drivers for the work, so that little time is consumed in chucking and taking out the finished parts. The gears are finished all over in three operations, within a limit of .003 of an inch and at the rate of twenty-five in nine hours.

These drills are especially adapted to a large line of automobile work, such as boring cylinders, boring and facing jack-shaft hubs and casings, sprockets, spur and bevel gears, etc. They are very massive to eliminate spring, and being equipped with spur gear drive and a very powerful feed, heavy cuts can be taken at high speed without springing or chattering.

LARGE DOUBLE-CRANK BENDING PRESS.

A machine quite similar in appearance to the "bull dozer," but possessing several distinct features not to be found in this type, has been brought out by the E. W. Bliss Co., Brooklyn, N. Y. It is a horizontal double crank press designed to do all the kinds of bending, either hot or cold, required in the manufacture of agricultural implements, automobiles, wagons, car trucks, etc. In most cases, the bending and forming of the iron parts used in these products must be done while the iron is hot. In deep bends, should the speed of the crosshead be too great, those portions of the article being bent which are not encompassed by the dies will be distorted by their own momentum. In order therefore to obtain the speed and length of stroke best suited to the work in hand, this machine is provided with three different lengths of stroke, and four variations in speed, as noted below. The machine is furnished with a powerful patented friction clutch, which may be operated automatically so that the die slide will always stop in a position furthest away from the die bed, or it may be set to be operated by hand, in which case the operator may start or stop the machine at any part of the stroke, allowing of "coaxing" operations, as they are called, which are quite frequently needed for complicated bends, the change from one method to another being very easily and quickly effected. As now built, two flywheels are employed instead of one.



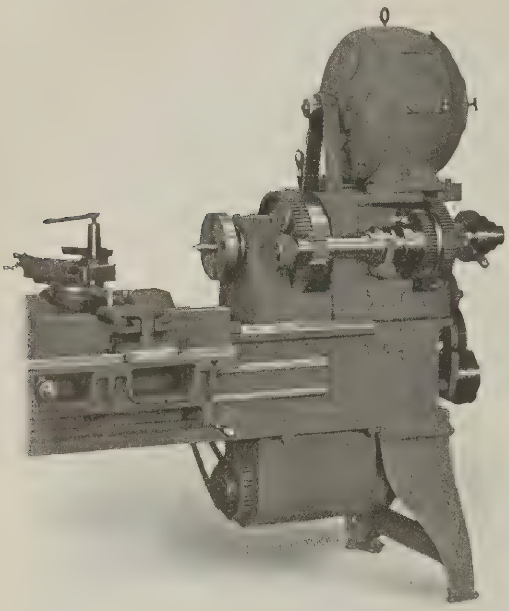
Horizontal Double-crank Bending Press, E. W. Bliss Company.

The general dimensions are: Weight, 25,000 pounds; diameter and width of flywheel, 32 x 4 inches; weight of flywheel, 600 pounds; width of slide and bed, right and left, 72 inches;

strokes of slide, 14, 16 and 20 inches; number of strokes per minute, 6, 12, 18 and 25; total height 84 inches; floor space over all, front and back by right and left, 150 x 70 inches.

MOTOR-DRIVEN ENGINE LATHE.

The accompanying illustration shows an 18-inch Le Blond engine lathe driven by a size 5 I shunt-wound Crocker-Wheeler motor. The motor is supported on a special housing and the drive is by means of a Morse silent chain from motor shaft to main lathe spindle. The speed control is accomplished by the Crocker-Wheeler multiple system, using in this case a size 40 M. F. 21 controller, giving a range with the controller of 21 speeds. Only a portion of this range is used as working speeds, the entire range of the tool being increased by a double back gear attachment which permits a total speed range of from 410 revolutions per minute of the spindle to 5.75 revolutions per minute.


Motor Attached to Le Blond Lathe.

With this entire range three runs of gearing are provided, one being direct and the other two through back gears. Each of these various runs is controlled by a friction clutch, the lever for operating which is located in front of the headstock. About 40 speeds are provided with 2.8 horse power, available at any speed between 20 and 410 revolutions per minute of the spindle. For the heaviest working range of the tool, however, namely: 28 to 124 revolutions per minute, 3.4 horse power is available.

A feature of this equipment is that it affords speeds to properly use these high cutting speeds and gives ample power at all speeds without an excessively large motor.

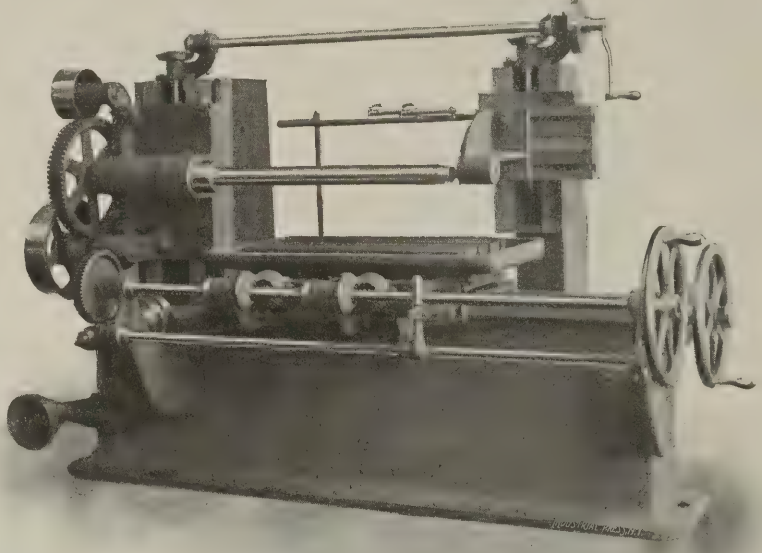
MILLING MACHINE WITH LONG ARBOR.

The milling machine illustrated herewith is designed to carry cutters at a greater distance from the driving head than is possible in the usual standard types of machines. Cutters can be placed about 36 inches from the spindle head, which is very convenient in milling slots in pieces about 30 inches long—the class of work for which the machine was intended. The machine is very heavy and substantial, and weighs 8,500 pounds.

The work table is 32 inches long by 18 inches wide, and has a movement of 12 inches at right angles to the spindle. It is provided with four automatic feeds as well as hand movement; is operated by two parallel screws and has an automatic stop. The saddle which carries the work table has a movement on bed of machine of 32 inches. This is moved by a screw; the hand wheel being provided with a graduated dial.

The spindle and outer support are moved simultaneously by screws from the crankshaft shown at the top of machine, also provided with a graduated dial, and the adjustment is such that the center of spindle can be brought within 2½ inches of work table surface and 13 inches above. The spindle is driven by a 4-inch belt running on a 14-inch pulley, compound geared to the spindle in the ratio of 10 1-10 to 1.

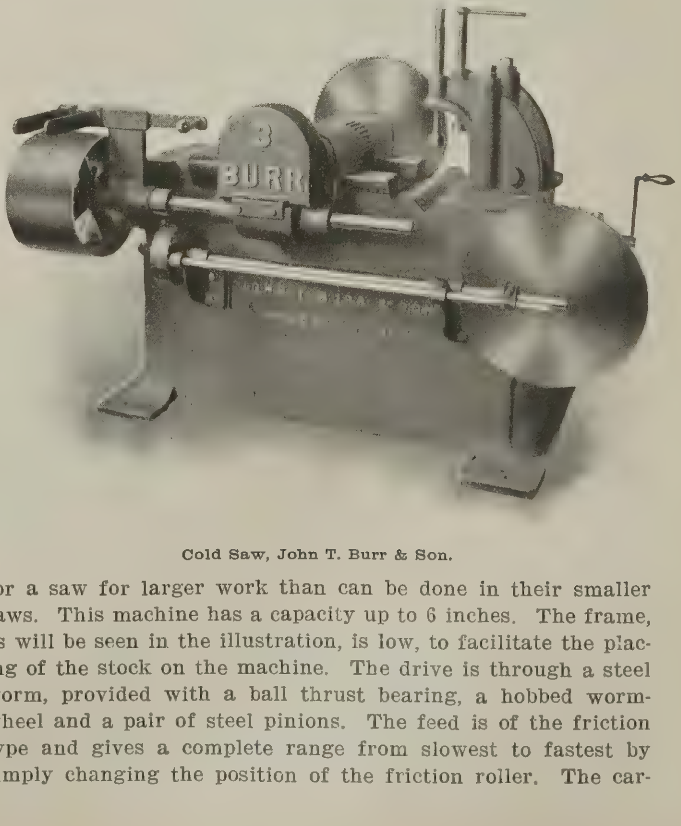
The machine is provided with a pump, oil tank and piping, fitting it for steel work. The outer support for spindle is provided with a longitudinal movement sufficient to allow the placing and removal of cutters without disturbing its alignment.


Special Milling Machine made by the Beaman & Smith Company.

The same belt which drives the spindle also drives the feed works and by the use of an idler above the spindle, the vertical adjustment of spindle does not alter the tension of the driving belt which is taken from the countershaft and runs about 140 revolutions per minute, with tight and loose pulleys of the usual equipment. The machine was built by the Beaman & Smith Co., Providence, R. I.

THE BURR COLD SAW.

A new and larger size of cold saw has been designed and recently placed on the market by John T. Burr & Sons, Brooklyn, N. Y. This is being manufactured to meet the demands for a saw for larger work than can be done in their smaller saws. This machine has a capacity up to 6 inches. The frame, as will be seen in the illustration, is low, to facilitate the placing of the stock on the machine. The drive is through a steel worm, provided with a ball thrust bearing, a hobbed worm-wheel and a pair of steel pinions. The feed is of the friction type and gives a complete range from slowest to fastest by simply changing the position of the friction roller. The car-

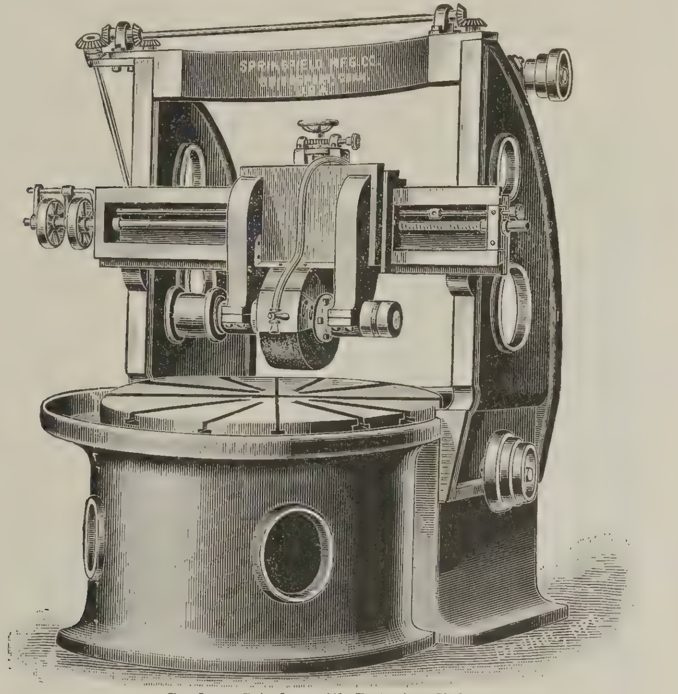


Cold Saw, John T. Burr & Son.

riage is very heavy, is substantially gibbed to the bed and has a travel of 8 inches on the bed. The saw is 16 inches in diameter and ⅛ inch thick. A grinding attachment is provided with each machine, which may be quickly removed when not in use. The emery-wheel spindle is driven by a belt from the pulley on the driving shaft. The saw is placed on the grinder slide, which is provided with an adjustable stop, so that each tooth may be ground to exactly the same depth, and a tooth gage, as in a cutter grinder, registers the teeth to the wheel. The machine weighs about 1,500 pounds.

SPECIAL SURFACE GRINDER.

A new departure in surface grinders is that recently brought out by the Springfield Mfg. Co., Bridgeport, Conn., for accurately grinding surfaces more or less open, like engine and pump valves, textile plates, etc. The wheel of this machine has a broad face and passes over the work at many different angles, which is accomplished by the table revolving and the wheel oscillating from side to center of the work, thus overcoming the trouble experienced in getting accurate work on surfaces more or less perforated. In many cases of surface grinding the wheel is liable to grind the inner edges more than the body of the work, but with this machine a perfectly even surface is secured. The manufacturers also state that surfaces on square segment or round dies can be ground on this machine at a greatly reduced cost.


SPRINGFIELD MFG. CO.

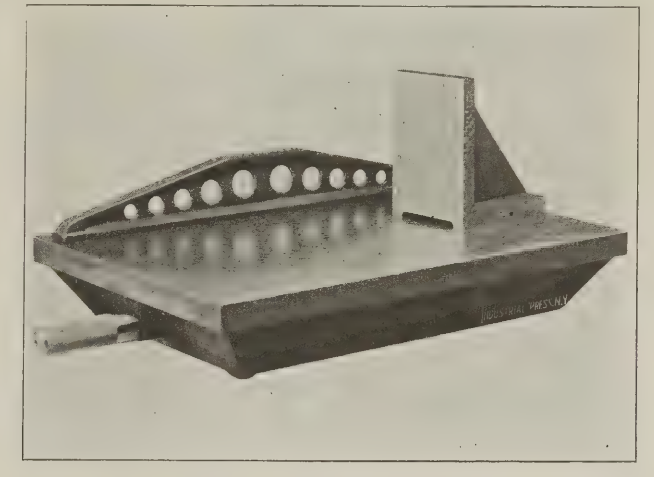
Surface Grinder with Rotating Table

The construction is, in some ways, similar to that of a boring mill, and is made clear in the cut herewith. The table rests on V-ways and is operated by worm and worm gear. Provision is made for oiling the ways through the table. The wheel head works either automatically or by hand, from side to center of the rail, and is operated with a screw driven by two pulleys, which in turn are driven by one straight and one cross belt. On the shipping rod, which runs parallel to the screw, are two adjustable dogs which govern the travel of the wheel, and any desired length of travel from side to center may be obtained. The cross rail which carries the wheel head is operated by elevating screws and the wheel head is also operated by an elevating screw and attached to it is a micrometer feed admitting of less than one-eighth of one-thousandth inch, if desired. The machine is designed for and equipped with water attachments and is built in three sizes to grind work 24, 40 and 60 inches in diameter.

SURFACE PLATE SET.

The illustration herewith shows a surface plate set consisting of surface plate, straightedge, and knee or angle plate, all of which are scraped accurately and to a degree of perfection which the makers—the Hazelton & Donald Machine Co., Philadelphia, Pa.—guarantee to meet the most exacting tests. There are also four setting-up blocks, to be used where it is desired to set pieces for testing clear of the surface plate. Two knurled grips are furnished to facilitate handling the plate, where it may be used as a rubbing or testing plate on milling machine standards or like surface work. A hardwood case is furnished with the set, which makes an inclosure for the plate when set on the bench for general use. The set is intended as a comprehensive outfit for jig and tool room work.

In designing the plate the makers use features of construction on which they have made application for patents. The common method of surface plate construction is that of an open or broken ribbing in combination with a 3-point support. With this form of construction there is a tendency for unsupported parts of the plate to sag and to assume a different degree of deflection when on the 3-point support from what is the case when it is held by the handles in an inverted position.



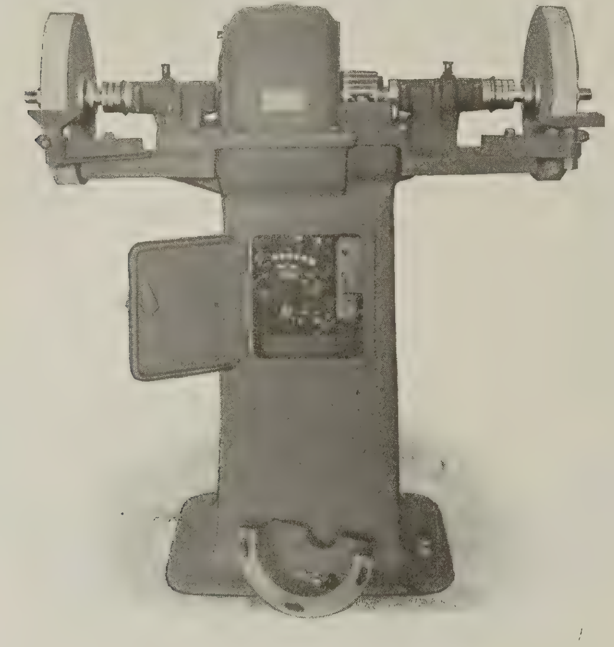
Hazelton & Donald Surface Plate Set.

In the Hazelton & Donald plate the ribbing is of a deep closed rectangular system, so proportioned that whichever side of the plate is uppermost the accuracy is maintained. For its support the surface plate proper rests upon five points, distributed in suitable positions, to insure equal support to the whole mass. Two of these corner supports rest upon two like solid points of a frame which is constructed as a 3-point support. The two opposite corners rest upon the arms of a lever which, in turn, rest upon a fulcrum located at such a distance from the center of the plate as to compel the equilibrium of the surface whether loaded with work or not. This same lever also has an arm for the support of the center of the plate. Owing to the proceedings for securing a patent upon this arrangement, full details are not yet available.

ELECTRICALLY-DRIVEN BUFFING LATHE.

A new line of buffing lathes and dry grinders (see next page) has been placed on the market by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., who provide the grinder portion, while the Crocker-Wheeler Co. furnish the motor equipment. Instead of extending an ordinary motor spindle and making a base to fit the motor, the emery wheel builder supplies shafts upon which the Crocker-Wheeler Company mount their armatures. The shaft is larger and stronger than necessary for an ordinary motor shaft and supported by unusually long bearings to secure rigidity against the vibration to which these tools are subject. The design of the motor is slightly modified to make the two a harmonious unit in every particular. Machines of this class must of course be fully inclosed, and the problem of cooling by air is a serious one. This has been solved by having the lower half of the motor open directly into the base casting. The air contained in the inside of the base is thus added to the quantity that circulates around the inside of the motor, and enables it to run much cooler than an ordinary fully inclosed motor of the same size and capacity. By this means of inclosure from five to eight times as much cooling air is available as in ordinary fully inclosed motors of equal power, the base also giving an increased surface from which to radiate the heat.

The armature and brush mechanism is covered with an end shield, split horizontally. The lower half contains the brush holders and wire connections; the upper half is attached to the motor frame by cap screws. This upper half of the frame can thus be readily taken off, giving quick and easy access to the armature and brushes.



Buffing Lathe, Electrically Driven.

The machines are equipped with ring oiling bearings. On the outer end of each box is a dust-proof collar, held in place by a key with two ring nuts, to compensate for end wear and thrust of the spindle.

INGERSOLL-SERGEANT FORGE.

We show herewith an illustration of the Macdonald forge, for use chiefly in heating rivets, but which is very handy when doing any general outside steel construction work upon which pneumatic tools are used and where compressed air is therefore available.

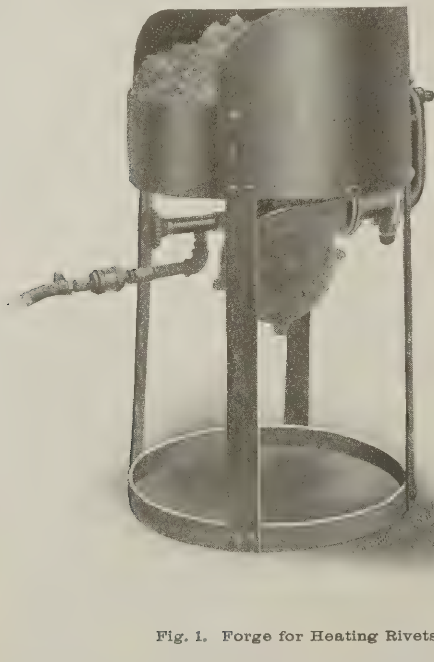


Fig. 1. Forge for Heating Rivets, etc.

The details of construction of the blower and jet are shown in Fig. 2. A small volume of air issues from the jet at a high velocity, which, by giving the blower a rotary motion, induces a mild blast of a large volume of air, such as is required to give the best results in producing a bright fire. In other words, a small volume of air under high pressure is converted into a large volume of air under low pressure.

This forge is manufactured by the Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York City.

A NEW SCREW-CUTTING BENCH LATHE.

There seems to be a growing demand for an accurate and reliable bench lathe that can be bought at a moderate price and at the same time is a complete screw-cutting lathe, suitable for laboratory, electrical, optical, model, experimental work, etc. The "Star Special" screw-cutting bench lathe shown by the accompanying half-tone has been built by the Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., to supply this demand.

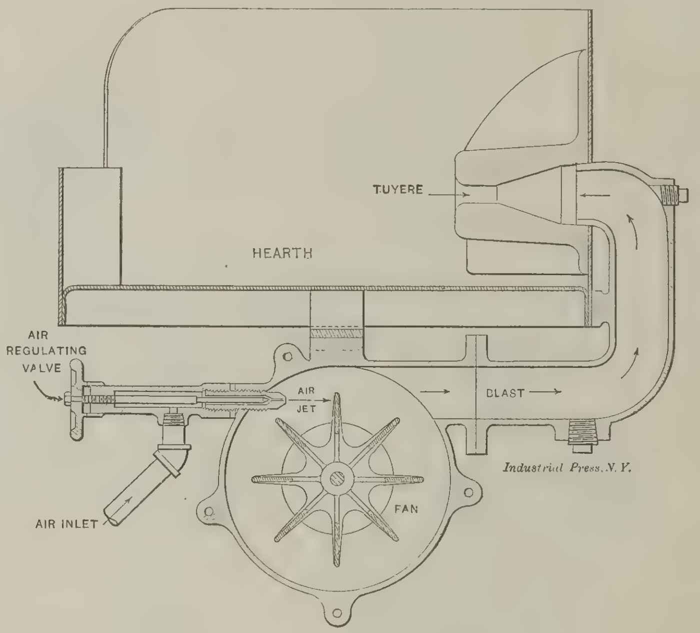
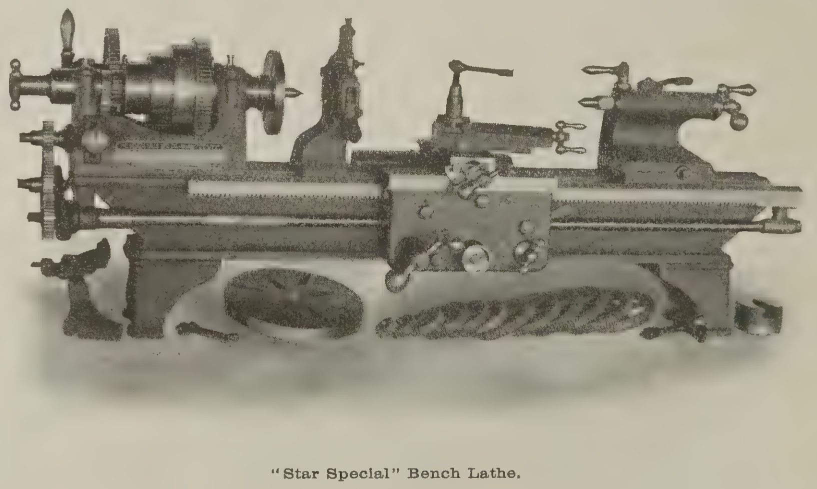


Fig. 2. Details of Construction of Forge.

The headstock has a large hollow spindle, made from a crucible steel forging, with draw-in chuck for split collets up to ½ inch capacity and phosphor-bronze boxes with improved end-thrust ball bearings; the cone pulley has three steps for wide belt. A push pin on the head gear allows the cone to be locked or unlocked without using a wrench. The tailstock is the curved or cut-under pattern.

The carriage has long bearing on the ways, and is gibbed to bed both front and rear. A cam-locking device locks carriage to bed when using cross-feed. The cross-feed screw has a graduated collar which reads in thousandths of an inch and can be set at zero in any position. Plain and compound rests are regularly furnished and easily interchange. The base is graduated 180 degrees and renders the compound-rest capable of fine adjustment. The toolpost has patented collar and shoe which exclude dirt and chips, and admit of quick and secure adjustment of the tool.



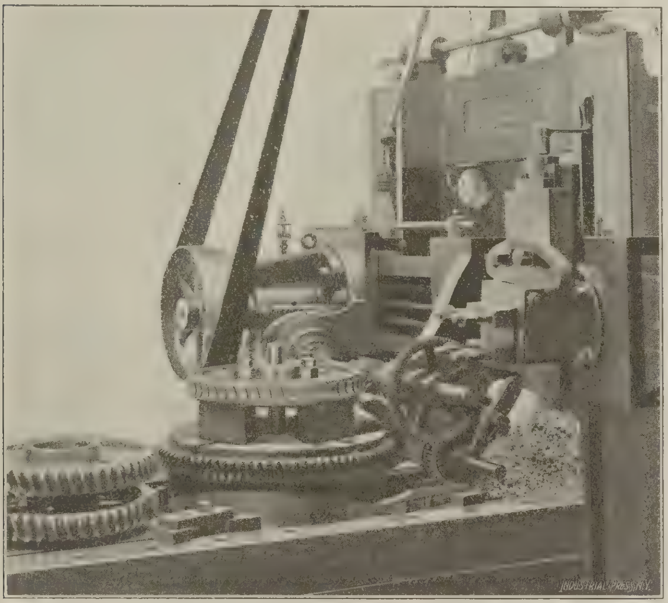
"Star Special" Bench Lathe.

The automatic cross and longitudinal feeds are actuated by a phosphor-bronze worm on the leadscrew, which is splined and acts as a feed rod. The range of feeds is large and the range for screw-cutting is extra large, cutting all standard threads, right or left (including 11½ and 27), from 3 to 64, without compounding the gears, and nearly all threads by compounding. The lathe will be supplied, if desired, with transposing gears and index for cutting International Standard Metric threads; or it can be fitted for cutting metric threads alone. The change gears are held in place by split washers and spring nuts. The lathe is rated as 9-inch swing, but will actually swing 10⅛ inches and 24 inches between centers. The countershaft has friction clutch pulleys. A large number of attachments are built for this lathe, so as to make it of as great utility as possible for a wide range of work, and it is supplied with the usual faceplates, rests, etc.

FARWELL MILLING ATTACHMENT.

The half-tone on this page illustrates a new use for the Farwell milling attachment—that is, the hobbing of bronze wormwheels. The Adams Co., Dubuque, Ia., who build the Farwell miller, inform us that this method of cutting wormwheels is employed in their shop on four sizes of wheels, two of which are cut with single-thread hob and two with double-thread hob.

The bronze blank is set on the revolving table which is turned at the proper speed to allow the hob to be fed into the blank without being first slashed with a single cutter. A worm which engages the teeth on the end of the table drives the table, and the correct speed of the table is secured by the use of gears of proper ratio between hob and worm. By changing the hob, blank and gears, a great variety of wormwheels may be cut.

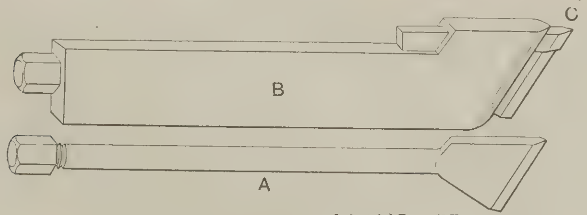


Milling Attachment Hobbing Worm Wheels.

This miller is designed for use in combination with a planer and is made in four sizes.

PARAGON TOOL HOLDER.

The advantages claimed for this tool-holder are that there is no setscrew to twist off, or to stand in the way when planing up close to a shoulder; the cuttings can curl off the cutter without packing between the end of the holder and the work; the cutter is solidly supported by the wedge-bolt nearly out to the point; the cutter can be instantly released, no matter if the cuttings and dust do pack around it; if the wedge-bolt strips it is a simple matter to weld on a new end; etc. The holder is made of steel and is oil-tempered, and is made extra long in the shank, a feature that is useful when a long reach is necessary. In the cut *A* is the wedge-bolt, *B* the holder and *C* the cutter. This tool is made by the Toronto Machine Co., Toronto, Ohio.



Industrial Press, N.Y.

Paragon Tool Holder.

FORGED STEEL FLANGES.

The American Forged Steel Flange Co., 64 Wabash Avenue, Chicago, Ill., are manufacturing forged steel flanges for pipe work, suitable for riveting to pipe of any size from 3 inches to 14 inches diameter. The flanges are of sufficient thickness to withstand extremely high pressure when bolted together; while the hub, or portion that extends over the pipe is thin enough for punching, and when driven over the pipe both the flange and pipe can be punched at the same time, thus doing away with the labor of drilling. The flanges are forged from the best grade of soft steel and are practically indestructible.

* * *

FRESH FROM THE PRESS.

The Economical Burning of Coal without Smoke is the title of a small book by A. Bement, the well-known author of articles on gas engines and other subjects pertaining to furnace economy. The book is published by the Peabody Coal Co., Chicago, Ill., and its text deals to a considerable extent with the possibilities of smoke prevention when the washed coal is employed.

New York Air Brake Catechism, by Robert H. Blackall, author of Air Brake Catechism (Westinghouse). 254 pages, 5 x 7¼ inches. Bound in cloth, and fully illustrated. Published by Norman W. Henley & Son, New York. Price, $1.25.

The public, interested in the airbrake, is so familiar with the author's excellent work on the Westinghouse apparatus, which has passed into the eighteenth edition, that it is not necessary to give this work an extended review. It is sufficient to state that the catechism of the New York Air Brake is given in the same general style and is illustrated with clear wax engravings showing sections of the different parts from which their functions may be readily understood in connection with the text. The book contains nearly 1,000 examination questions and answers on this brake and signaling apparatus and should be invaluable to trainmen and others having charge of the New York type.

The Derry Collard Co., 256 Broadway, New York, have prepared, and now have for sale, some new sketching paper for making drawings in isometric projection. This paper is ruled with faint green lines, for the guidance of the draftsman in making freehand sketches in isometric projection. This paper is put up in pads or is sold in single sheets, as desired. The pads have 40 sheets each and are made in sizes 6 x 9, price 25 cents, and 9 x 12, price 50 cents. The loose sheets are in sizes 12 x 18, price 5 cents each, or 40 for $1.00. This isometric paper will be appreciated by draftsmen as isometric projection is the only perspective where sketches are to be according to scale. The only difficulty in using the paper is in drawing circles. This seems puzzling at first, but becomes very simple when it is remembered that the isometric ellipse is in the ratio of 1 to 1.732, or nearly 1¾ when its short axes cross the short diameter of the diamond formed by the isometric lines.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

The Buffalo Forge Co., Buffalo, N. Y. Illustrated booklet of the "Buffalo" disk wheels for ventilating purposes. These are driven by pulley, by steam or electricity.

The American Blower Co., Detroit, Mich. Catalogue No. 161 of the "A B C" disk ventilating fans for heating, ventilating and drying Different styles and sizes of these are shown and described.

The Scott & Sons Co., Medford, Mass. Booklet illustrating the "Ess-Ess" turret lathes manufactured. This company also make the "Ess-Ess" collet chucks, automatic dies, automatic taps, etc.

The Niles-Bement-Pond Co., New York. "The Progress Reporter," a sheet illustrating by a number of large and handsome cuts some examples of the machines designed and constructed by the different companies representing this firm.

S. W. Card Mfg. Co., Mansfield, Mass. 1904 catalogue, pocket size, of machinists' tools. These include taps, dies, screw plates, etc., which are all illustrated here and prices given. Several useful tables also appear.

The National Electric Co., Milwaukee, Wis. Catalogue No. 61 of direct-current generators and motors, for lighting, power and railway service. These are built in capacities from 2 horse-power up to 1,500 kilowatts. The catalogue describes the various styles, and handsome illustrations accompany the text.

The Garvin Machine Co., New York. Complete illustrated catalogue of the Garvin products. This catalogue is pocket size, contains 210 pages, and shows their line of metal-working machine tools. They call attention to many new things. This book will be found useful and, owing to its size, very handy for reference.

The Blaisdell Machinery Co., Bradford, Pa. Bulletin 11, of the "Blaisdell" air compressors. This special bulletin describes their Classes AA and AD single air compressors, with illustrations of each type; the self-oiling compressors of their manufacture being shown in another bulletin.

The F. E. Reed Co., Worcester, Mass. Illustrated catalogue, 1904, of machine tools. Engine lathes of from 10 to 30 inches swing; special turning lathes; bench lathes; wood turning lathes; stud and bolt lathes; turret head chucking lathes; gun barrel turning lathes; forming lathes, etc., and several special machines are illustrated. Their patent friction countershaft is also shown.

The Minneapolis Steel & Machinery Co., Minneapolis, Minn. Catalogue illustrating the "Twin City" Corliss engines. The whole book is devoted to handsome cuts showing the different styles of these engines and their parts, also views of various plants where these engines are installed. The company also manufacture steam pumps, air compressors, condensers and a full line of transmission machinery.

The Brown & Sharpe Mfg. Co., Providence, R. I. Booklet illustrating and describing a new line of calipers and dividers recently placed on the market and having round legs instead of the usual flat form. This adds materially to the stiffness of the tool without increasing its weight—a feature making it particularly acceptable to toolmakers and others having to do fine work. Three styles are made: Dividers, outside calipers and inside calipers in sizes 2, 3 and 4 inches.

The Great Lakes Engineering Works, Detroit, Mich. Catalogue D, 1904, describing the "Great Lakes" twin vertical air pump and condenser, built in sizes from 14 x 9 to 60 x 22 and furnished with or without condensers and with or without tank pumps. This company are also marine engine and steel ship builders, and manufacturers of hydraulic dredging machinery, air compressors for heavy duty, marine boilers, etc.

The Newton Machine Tool Works, Philadelphia, Pa. Catalogue No. 38, illustrating the "Newton" slotting machines. Several of these are new and all have been increased in weight to meet the requirements of high-speed steels. Slotting machines of from 6 to 50 inches stroke are shown, some of which are equipped either with motor drive or with change gear drive. Several sizes of portable slotting machines appear, also a 16-inch traveling head slotting machine, and an armor plate slotter.

The Lucas Machine Tool Co., Cleveland, O. Two cleverly gotten up little circulars entitled "The Mathematical Cook" and "Jackass Power," calling attention to the Lucas boring, drilling and milling machine and the Lucas power forcing press respectively. A third circular describes the forcing press, which is designed to do *by power* a large variety of shop operations hitherto performed with sledge hammers and hand presses.

The Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill. 1904-5 catalogue and price list of drawing materials and surveying instruments. This book contains 411 pages, and in the preface the company state that they have made every effort to make this edition a truly representative one and they call particular attention to the new things listed, among which are their new line of "Richter" instruments of precision, also the surveying instruments of their own manufacture.

The Mueller Machine Tool Co., Cincinnati, O. Illustrated booklet describing the radial drills manufactured. Three styles are shown: With 2½-foot arm, 3-foot arm and 4-foot arm, and drilling respectively to the center of a 5-foot, 6-foot and 8-foot circle. A universal center grinder is also shown and described. The catalogue will be mailed to any one wishing same. The agents for this company are: Niles-Bement-Pond, the Pratt & Whitney Co., Strong-Carlisle & Hammond Co., Chas. G. Smith Co., and Henshaw Bulkley & Co. (See advertisement.)

The Bickford Drill & Tool Co., Cincinnati, O. Folder entitled "Bouquets," containing, as the title implies, bouquets in the form of testimonials sent to the Bickford Co. by their many patrons regarding the efficiency of the new Bickford radials. These letters are from prominent firms in the country, and in almost each instance a positive statement as to what is accomplished with the Bickford radial is made. Then follow two or three pages of names of reputable concerns who have recently installed one or more of the Bickford drills. Such arguments are certainly convincing.

MANUFACTURERS' NOTES.

The Jacobson Machine Mfg. Co., Warren, Pa. Leaflet illustrating and describing the "Jacobson" gas and gasolene engine, built in sizes from 3 to 30 horse-power.

Joseph Dixon Crucible Co., Jersey City, N. J. Folder descriptive of the graphite dressing for wire ropes, for lubricating purposes. Also pamphlet telling of the good points of "Dixon's" pipe joint compound.

The Billings & Spencer Co., Hartford, Conn. Circular of drop forged hammers for machinists' use. These are shown in three styles: The ball pene, the straight pene and the cross pene, and weigh from 4 ounces to 2 pounds.

Patterson, Gottfried & Hunter, Ltd., 146-150 Centre St., New York, have undertaken the sole distributing agency for the "Pioneer" pressed steel shaft hanger, for New York, New England and upper New Jersey.

The Auburn Ball Bearing Co., manufacturers of thrust and journal bearings of all sizes, have removed their main office and works from Auburn, N. Y., to 18 Commercial St., Rochester, N. Y., where they will have increased facilities for the manufacture of their products.

The Superior Corundum Wheel Co., Waltham, Mass., inform us that M. F. Cunningham, for fifteen years with the Waltham Emery Wheel Co., has assumed the management of their company, and is making emery and corundum wheels and stones for all purposes.

The F. Bissell Co., Toledo, O. Bulletins Nos. 31, 36 and 37 and "Handbook of Switchboards." Bulletin No. 31 treats of tape, solder, screws, insulating materials and carbon brushes, etc.; No. 36, of batteries; No. 37, of house goods. The "Handbook" deals with switchboards of 2,500 amperes and less.

J. E. Snyder, Worcester, Mass., manufacturer of upright drills, announces that he has taken his son, Milton C. Snyder, into partnership with him and that hereafter the business will be conducted under the name of J. E. Snyder & Son. Mr. Milton C. Snyder has been engaged in the business for several years.

The Magneta Co., of Zurich, Switzerland, manufacturers of electric clocks without batteries or contacts for factories, office buildings, railroads, etc., have established a branch office in New York at No. 11 Broadway, for the introduction of their electric clock systems in this country. The office is in charge of W. Hommel, United States representative of the above company.

The Perkins Machine Co., formerly at South Boston, Mass., have removed their main office to the Warren plant at Warren, Mass., where all communications should be addressed. They announce that they have recently received large orders from their Berlin agents, Schuchardt & Schutte, and have shipped ten machines to different parts of Germany.

H. F. Frevert for a number of years manager of the New York stores of the Niles-Bement-Pond Co. and Pratt & Whitney Co., has severed his connections with those companies and opened an office at 114-118 Liberty Street for the sale of machinery. Mr. Frevert is also manager of the New York office of the Norton Grinding Co., of Worcester, Mass., and the Brightman Mfg. Co., of Shelby, Ohio.

The Watson-Stillman Co., formerly at 202 E. 43d St., New York, removed on May 1st their offices and large stock of goods to 46 Dey St., and all their machinery to their new works at Aldene, Union County, N. J., at the juncture of the Lehigh Valley and Baltimore & Ohio R. R. and on the low grade connection between the Lehigh Valley and the Central Railroad of N. J., where they will have ample room to expand and handle such work as comes to them.

The Carborundum Co., Niagara Falls, N. Y., recently shipped two freight cars with their products to St. Louis for an exhibit which will occupy Block No. 16 in Machinery Building. They state that this will be one of the most elaborate exhibits ever made by them, and one of the principal features will be a great pyramid of carborundum crystals, 7 feet high, and 6 feet in diameter at the base. The display will be in charge of William H. Arison and E. W. Taylor.

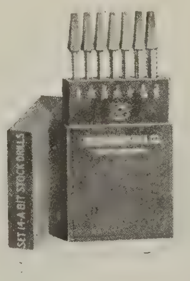
The Hartford Blower Co., Hartford, Conn., have received a large order from Sargent & Co., New Haven, and one from the Scovill Mfg. Co., Waterbury, for Hartford mechanical dust collecting systems for their plants. The Hartford Co. make a specialty of installing the above-named systems, as well as heating, ventilating and drying systems, mechanical draft, dry kilns, blowers, exhaust fans, etc. Their new catalogue No. 57, entitled "Dust Collecting," will be mailed to anyone interested.

The International Correspondence Schools, Scranton, Pa., are represented at St. Louis by a handsome structure facing the Plaza in the Model Village. The lower floor of this building is devoted to a public exhibition of the plans and methods of the Schools, with specimens of the work of the students. The second floor will be used as a post office, reading and writing room and *rendezvous* for the Schools' students and their friends. Their book, "1,001 Stories of Success," will be mailed upon request.

The Ramsey & Thornley Machine Co., 51 Godwin St., Paterson, N. J., manufacturers of special light machines, announce that they are making a specialty of the following: Jigs and all kinds of special tools designed and built to facilitate manufacture. These they design from prints, sketches or samples of the piece to be manufactured. Also small gears; screw machine work; sheet metal dies; experimental work; and pattern making. Special attention is given to developing patents.

Manning, Maxwell & Moore, New York, were recently awarded the entire contract for the tools and machinery for the railway shops of the Southern Pacific Co., including shops at 18 different points. This order consists of tools for machine shops, boiler shops, locomotive and car shops, and is, they think, the largest single machine tool order that has been placed in this country in many years. They have also secured contracts for the Shaw Electric Crane Co. for electric traveling cranes, and for the Hilles & Jones Co. for punching and shearing machinery, besides a large order from the Maine Central R. R. for boring mills, engine lathes, upright drills, shapers and grinding machinery.

The Robertson Mfg. Co., Buffalo, N. Y., have recently brought out another size of the rapid cut power hacksaw. This is the No. 4 which has a capacity of 8x15 inches. This has been built to meet the demand of customers and others for a "larger machine on the same model." It is similar in design to their No. 3, being back-geared, but the vice is of new design, quick-acting and graduated in inches, and there is also a quick-acting clutch. No countershaft is required, and when the cut is complete the machine stops automatically. This machine is built especially for I-beam cutting, but can also be used for all kinds of cutting of iron or steel bars, in rounds or squares, and for many other purposes.



The Standard Tool Company, Cleveland, Ohio, are offering their bit stock drills and wood brace drills, sets 14-A and 13-B, containing drills ⅛ to ⅜ in. by 32ds, in flat leatherette cases, as here illustrated. These cases are very convenient to carry in the pocket. The drills fit in holes drilled for each size, which is plainly marked on the box, in gold, beneath the corresponding drill. These compact little cases will also be very useful in the tool chest as they take up but little room, and the drills can always be found clean and ready for use. Where economy in preserving drills is a consideration, these handy sets will appeal as well worth the cost, which is but little over the price of the drills themselves.

SUMMARY OF NEW TOOLS, CATALOGUES, ETC.

IN THIS NUMBER.

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MACHINERY.

July, 1904.

PROBLEMS IN BEAMS AND PLANES SEVERALLY SUPPORTED AND ECCENTRICALLY LOADED.

C. F. BLAKE

Among the troublesome problems that sometimes occur to the designer are the cases of beams carrying a concentrated load, or loads, and borne upon several supports, the reaction upon these supports being required. Such problems, however, may be easily solved by an application of the principles of the polar moment of inertia. Attention has already been called by the writer to the advantages of the application of these principles to the design of riveted joints, but as the usefulness of the polar moment of inertia method is not as well recognized as it should be, a few remarks upon its use in general may not be out of place before applying the method to the problems in hand.

The general formula for equilibrium under the polar system of co-ordinates is the same as that for the rectangular system with the subscript $_p$ added to the proper quantities to denote that they refer to the polar system.

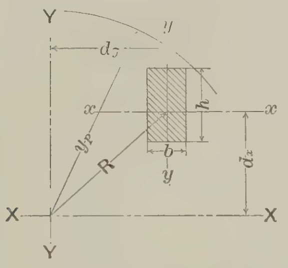

Fig. 1

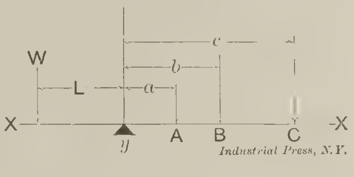

Fig. 2.

$$M = f\,\frac{I_p}{y_p} = f\,Z_p \;\ldots\ldots\ldots\ldots\ldots(1)$$

where M = the moment about the pole in inch-pounds.

f = the fiber stress upon the most remote fiber from the pole.

y_p = the distance from the pole to the most remote fiber,

I_p = the polar moment of inertia,

Z_p = the polar section modulus.

If, when considering the torsional resistance of any section about a given pole, we draw through that pole a system of rectangular co-ordinates, XX and YY, the polar moment of inertia of the section will be the sum of the two co-ordinate moments of inertia about these axes. Thus, referring to Fig. 1, let I_x and I_y be the co-ordinate moments of inertia of the section about the x and y axes respectively, these axes being drawn through the center of gravity of the section. Then from the well-known formula, the moments of inertia about the axes XX and YY respectively, are:

$$\left.\begin{aligned} I_X &= I_x + A\,d_x^2 \\ I_Y &= I_y + A\,d_y^2 \end{aligned}\right\} \text{ where } A = \text{the area of the section.}$$

Then, $\quad I_p = I_X + I_Y = I_x + I_y + A\,R^2$

Where several sections are grouped about a pole, the total moment of the group is the sum of the several polar moments taken separately as above for each section.

Thus for any number of sections,

$$I_p = \Sigma\,(I_x + I_y + A\,R^2) \;\ldots\ldots\ldots\ldots(2)$$

and substituting this value in (1) we have,

$$M = f\,\frac{\Sigma\,(I_x + I_y + A\,R^2)}{y_p} \;\ldots\ldots\ldots\ldots(3)$$

and

$$Z_p = \frac{\Sigma\,(I_x + I_y + A\,R^2)}{y_p} \;\ldots\ldots\ldots\ldots(4)$$

At present we are dealing with loaded points instead of sections, so I_x, I_y, and A approach zero, and (4) reduces to

$$Z_p = \frac{\Sigma\,A\,R^2}{y_p} \text{ approximately} \ldots\ldots\ldots(5)$$

From this we see that the torque set up by the reaction of a point is directly proportional to the square of its distance from the axis of rotation, and it is this fact upon which the following solutions depend.

In Fig. 2 let XX be a beam supported at y, loaded by a known load W at a distance L from this support, and prevented from rotating about y by the reaction of several points, A, B, and C, distant respectively a, b, and c from the support. Required the reactions A, B, and C. The torques of the reactions at the several points on the right of the support are proportional to the squares of their distance from y, therefore the total torque on the right of y is proportional to $(a^2 + b^2 + c^2)$, and the torque obtained from reaction

$$\left.\begin{aligned} A &= \frac{a^2}{a^2 + b^2 + c^2} \\ B &= \frac{b^2}{a^2 + b^2 + c^2} \\ C &= \frac{c^2}{a^2 + b^2 + c^2} \end{aligned}\right\} \text{ of the total torque,}$$

WL, on the left of y.

Since a force exerting torque about an axis is equal to the torque divided by the arm at which it acts, we have the force

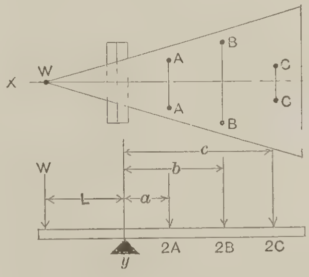

Fig. 3.

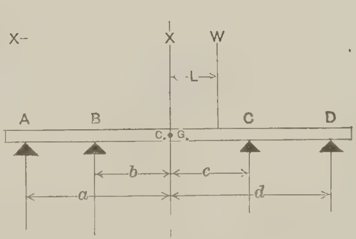

Fig. 4.

$$A = \frac{\dfrac{a^2}{(a^2 + b^2 + c^2)}\,W\,L}{a} = \frac{W\,L\,a}{a^2 + b^2 + c^2} \ldots(6)$$

Likewise the force

$$B = \frac{W\,L\,b}{a^2 + b^2 + c^2} \ldots\ldots\ldots\ldots(7)$$

and

$$C = \frac{W\,L\,c}{a^2 + b^2 + c^2} \ldots\ldots\ldots\ldots(8)$$

Thus, having the values of W, L, a, b, and c, we arrive at values for A, B, and C such that, acting through their respective arms a, b, and c, they will balance the force W acting through its arm L.

C. F. Blake was born in Boston, Mass., in 1871. He received his education at Cornell University and served with the Crane Elevator Co., the Standard Elevator Co. of Chicago (now the Otis Elevator Co.) and the Shaw Electric Crane Co., Muskegon, Mich., as chief draftsman and designer in crane work. His specialty is hoisting machinery. At present Mr. Blake is designer for the Shaw Electric Crane Co. He is a member of the American Society of Mechanical Engineers, and besides his articles published in MACHINERY, has written for a number of other technical journals.

Having found the values of A, B, and C, the force upon the support y is

$$W + A + B + C.$$

This is applicable no matter how many points of reaction there may be, nor how they are placed, so long as they are symmetrical about a line drawn through W. This is shown in Fig. 3, which represents a plane balanced upon a knife edge, having a load W on the left, and several points of reaction on the right, these points being symmetrically placed about the line $x\,x$. This problem may be treated exactly as that shown in Fig. 2, the resulting load upon the knife edge being uniformly distributed.

If the points are not symmetrical about $x\,x$, the same method may be used, but the resulting load upon the knife edge will not be uniformly distributed. Fig. 4 represents a beam severally supported at A, B, C, and D, and loaded at W. The line $x\,x$ is drawn through the center of gravity of the supports A, B, C, and D. The reaction of each support due to the torque WL is found by formula (6). Note must be made of the directions of these reactions; in Fig. 4 the load W would, in the absence of the supports, rotate the beam clock-wise about the center of gravity, hence the forces A and B are up, and the forces C and D are down. In algebraic addition to these loads at the several supports, each support will have a vertical load down of $\frac{W}{n}$ pounds, where n is the number of supports. Thus in Fig. 4 the load at A is

$$A = \frac{W}{n} - \frac{W\,L\,a}{a^2 + b^2 + c^2 + d^2} \ldots\ldots\ldots (9)$$

and the load at C is

$$C = \frac{W}{n} + \frac{W\,L\,c}{a^2 + b^2 + c^2 + d^2} \ldots\ldots (10)$$

etc., n being 4 in the case of Fig. 4.

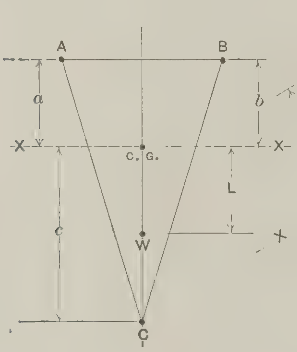

Fig. 5.

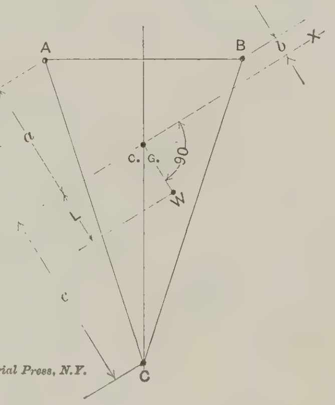

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Fig. 6.

Let Fig. 5 represent a plane severally supported at A, B, and C, and loaded at W; required the reactions at the supports. Locate the axis of rotation $x\,x$ through the center of gravity of the supports. Each support resists a down load of $\frac{W}{n}$, and at the same time a load due to the torque of WL about the axis of rotation $x\,x$, precisely as in Fig. 4, and the same formula (9) may be used.

Fig. 6 is the same as Fig. 5, except the load is not symmetrically placed as regards the supports. Locate the center of gravity of the supports, and connect this with the point of loading W. Through the center of gravity perpendicular to this line draw the axis of rotation $x\,x$. From each point of support drop a perpendicular to $x\,x$, thus getting the arms at which the reactions act. The reactions at the supports may now be obtained by formula (9). The method of Fig. 6 is applicable to any plane severally supported and loaded, since W may represent the center of gravity of any number of known loads upon the plane, and the formula may be extended for any number of supports.

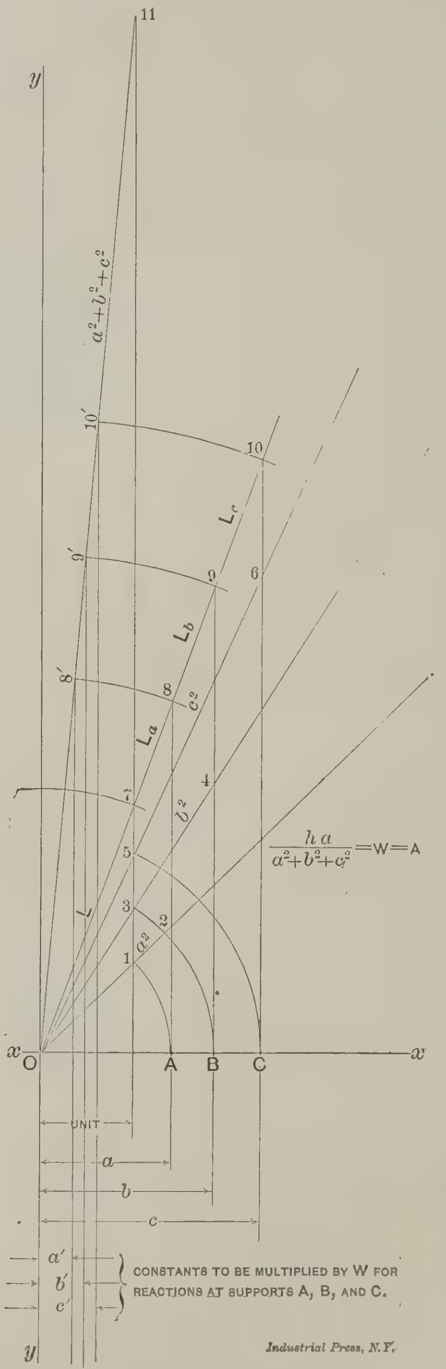
A graphical solution for formula (9) sometimes convenient is as follows: In Fig. 7 draw the rectangular axes xx and yy, and lay off a unit of the selected scale on xx. Also on xx lay off the arms at which the reactions act, a, b, and c, obtaining points A, B, and C. At these points erect perpendiculars, and also through these points pass arcs $A1$, $B3$ and $C5$, with o as center. Through the points 1, 3, 5, where these arcs cut the perpendicular from the unit point, pass radial lines from o, and extend them to meet the respective perpendiculars from A, B, and C at points 2, 4, and 6 respectively. Then

$$\frac{o\,1}{\text{unit}} = \frac{o\,2}{o\,A}$$

and since the unit equals 1, and $oA = o1 = a$, we have

$$\frac{a}{1} = \frac{o\,2}{a},\ o\,2 = a^2.$$

Likewise $o4 = b^2$ and $o6 = c^2$. With a radius equal to L, describe an arc cutting the unit perpendicular at 7, and draw a radial line through this point to cut lines from A, B, and C in 8, 9, and 10. Then $o8 = La$, $o9 = Lb$, and $o10 = Lc$.


11
y
$a^2+b^2+c^2$
10'
10
L_c
9'
9
6
L_b
8'
8
c^2
L_a
4
7
b^2
5
L
3
2
a^2
1
$\frac{h\,a}{a^2+b^2+c^2}$=W=A
x
O
A
B
C
x
UNIT
a
b
c
a'
b'
c'
CONSTANTS TO BE MULTIPLIED BY W FOR REACTIONS AT SUPPORTS A, B, AND C.
y

Industrial Press, N.Y.

Fig. 7.

Having found the lines representing a^2, b^2, and c^2, set the dividers to a radius equal to the sum of these lines, and with an arc cut the unit perpendicular at H. Draw oH. Transfer points 8, 9, and 10 to 8′, 9′, and 10′ on line oH by means of arcs struck from o, and from the latter points drop perpendiculars. The distances a', b', and c', when measured to the adopted scale, and multiplied by W give the reactions at A, B, and C respectively.

Like the formula, this diagram may be extended to cover any number of points of reaction. As in all written descriptions of graphical methods, the actual work required is far short of what seems necessary when first read, and is in reality very simple. The range of problems to which this method is applicable is very great, including the loads carried by machinery foundations, car loadings, beams, anchor plates, and many intricate details of machine design, in short any problem, no matter how intricate, that may be reduced to a plane supported upon several points, and carrying one or more loads, the center of gravity of which is known. The following problem will serve as an illustration:

Fig. 8 represents a four-legged spider or anchor plate, loaded as shown; the arms being of varying lengths we require the reaction at each support, in order to proportion the arm sections.

Draw *B C* and bisect it at *e*, also bisect *A D* at *f*. Join *e* and *f*, and bisect *e f* at *g*. Then *g* is the center of gravity of the supports *A*, *B*, *C*, and *D* if the load on each one is unity. Draw *o g*, and *x x* perpendicular thereto, and upon *x x* drop perpendiculars from *A*, *B*, *C*, and *D*.

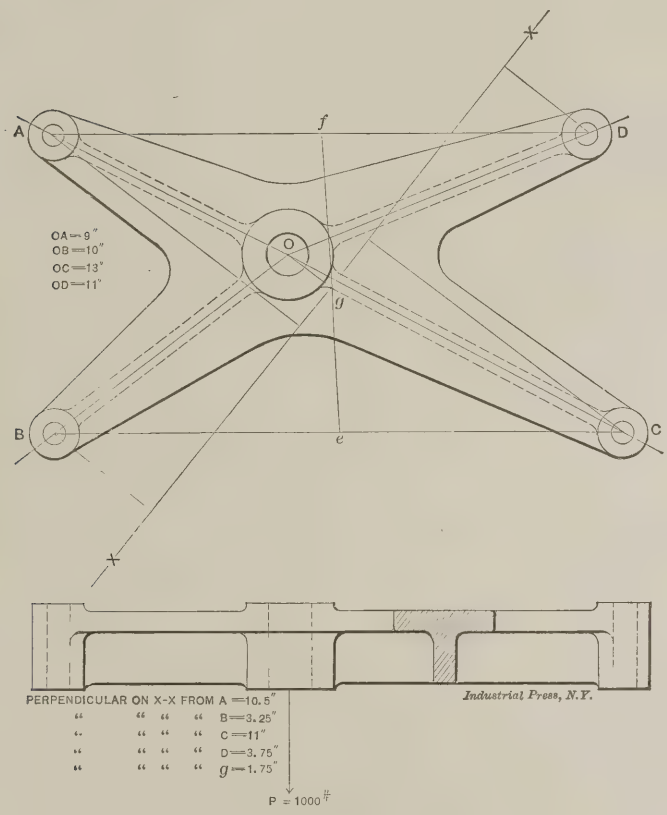


Fig. 8.

We then have from formula (6),

$$\text{Load at } A = \frac{1000 \times 1\ 75 \times 10.5}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 71.9 \text{ lbs. downward.}$$

$$\text{Load at } B = \frac{1000 \times 1.75 \times 3.25}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 22.14 \text{ lbs. downward.}$$

$$\text{Load at } C = \frac{1000 \times 1.75 \times 11}{(10.5^2 + 3.35^2 + 11^2 + 3.75^2)} = 75.35 \text{ lbs. upwards.}$$

$$\text{Load at } D = \frac{1000 \times 1.75 \times 3.75}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 25.63 \text{ lbs. upwards.}$$

$$1000 \text{ lbs.} \times 1.75 \text{ inch lbs.} = 1750 \text{ inch lbs.}$$

$$\begin{aligned} 71\ 9 \times 10.5 &= 754\ 95 \text{ inch lbs.} \\ 22.14 \times 3.25 &= 71.955 \\ 75.35 \times 11 &= 828.850 \\ 25.63 \times 3.75 &= 96.112 \\ \hline & 1751.867 \text{ inch lbs. check.} \end{aligned}$$

$$\text{Vertical load on each arm} = \frac{1000}{4} = 250 \text{ lbs. downward.}$$

$$\begin{aligned} \text{Resultant on } A &= 250 + 71.9 = 321\ 9 \\ \text{" " } B &= 250 + 22.14 = 272.14 \\ \text{" " } C &= 250 - 75.35 = 274.65 \\ \text{" " } D &= 250 - 25.63 = 224\ 37 \\ \hline & 1093.06 \text{ lbs. check.} \end{aligned}$$

The error, less than ten per cent., arises from dropping decimals in taking squares, and from slide rule readings, but the check is as close as practice demands.

* * *

VARIABLE SPEED MOTORS.—4.

THE BULLOCK SYSTEMS.

WILLIAM BAXTER, JR

The Bullock Electric Mfg. Co. use two systems for variable speed motors, one three- and the other four-wire. The three-wire system is arranged so as to give three different voltages, and the four-wire gives six. Thus by means of voltage variations, three speeds are obtained in one case, and six in the other. Intermediate speeds between those given by the several voltages are obtained by introducing resistance in the field circuit.

A diagrammatic representation of the four-wire system is given in Fig. 1, in which the upper part is a development of the controller, and the lower shows the general arrangement of the balancing transformer. This balancer is shown as consisting of three machines, but it is also made in the form of two machines, one of these being provided with two separate windings on the armature, and two commutators.

In Fig. 1 the lines + and — represent the mains coming from the generator to a two-pole switch S. Through *a*, the current passes to an automatic motor starter and thence through the armature and series field coil of the left-side machine, to line *b*. From the end of the series field of the first machine the circuit branches and passes through the armature of the second machine and thence through the series field coil to wire *c*. From *c* another branch passes through the armature of the third machine and through the series field coil to wire *d*. The wires *a b c d* run to a four-pole switch *S′*, by means of which the lines that feed the motors are connected or disconnected from the main, and the balancer circuits, whenever desired. Each motor is in addition connected with the main motor circuits by means of a four-pole switch as shown at *S″*.

TABLE 1. RHEOSTATIC CONTROL.

Amperes.		Volts.		Speed.			Work.		Diameter Piece.	Tool Position.
Arm.	Field.	Arm	Line	R.P.M. Motor.	R.P.M. Spindle.	Feet Peri-pheral.	Feed.	Depth.		
16.2	.82	179	236	652	218	210	......	......	....	A
25.7	"	54	"	203	67.6	65.3	21 to 1	$\frac{1}{64}''$	$3\frac{11}{16}''$	E
27.3	"	43	"	161	50.0	48.3	"	$\frac{1}{32}''$	"	C
33.6	"	....	"	......	....	......	......	$\frac{1}{16}''$	"	D

TABLE 2. RHEOSTATIC CONTROL.

Amperes.		Volts.		Speed.			Work.		Diameter Piece.	Tool Position.
Arm	Field.	Arm.	Line	R.P.M. Motor.	R.P.M. Spindle.	Feet Peri-pheral.	Feed.	D'pth		
16.2	.82	179	236	652	218	210	......	.....	....	A
53.5	"	53	"	189	63	60.8	21 to 1	$\frac{1}{8}''$	$3\frac{11}{16}''$	B
38.5	"	105	"	378	126	121.5	"	$\frac{1}{16}''$	"	C
27.3	"	143.2	"	515	172	165.5	"	$\frac{1}{32}''$	"	D
25.7	"	148.6	"	535	178.5	172.5	"	$\frac{1}{64}''$	"	E

The balancers, as will be noticed, are compound wound, the object being to maintain the voltage between the several lines more nearly constant than it would be with a plain shunt winding. The way in which the compound winding acts to keep the E. M. F. more uniform will be explained in connection with the three-wire system. The shunt field coils are connected directly across the generator lines, each one in a separate circuit, and provided with its own regulating rheostat.

The three balancer machines develop voltages of 60, 80 and 110, and by combining these, six different voltages are obtained, as is shown at the right side of the diagram. As the lowest voltage is 60 and the highest 250 the speed variation due to voltage alone is a little more than 4 to 1. By the aid of field regulation the total range of speed of the motor is about 7½ to 1. The resistance introduced into the motor field to obtain the additional regulation is proportioned so that four speeds are obtained with each voltage, except the highest, with which six speeds are obtained, thus making the total number of speeds 26. As the lowest voltage is only about one-quarter of the highest, no starting resistance is required in the armature circuit, and this fact materially simplifies the construction of the controller.

The controller is of the cylindrical type, and consists of two cylinders, *A* and *B*, one of which carries the part marked "Drum 1" in the diagram, and the other carries drums 2, 3 and 4. These two cylinders are connected with each other by means of a specially arranged gearing, so that while drum 1 has a uniform motion, the other cylinder moves step by step. The cylinder *A* that carries drum 1 drives the other cylinder. When cylinder *A* is moved to the first position, it carries cylinder *B* to the first position; but while *A* is being moved toward position 2, *B* stands still and does not move until *A* reaches the second position, when it moves rapidly to position 2.

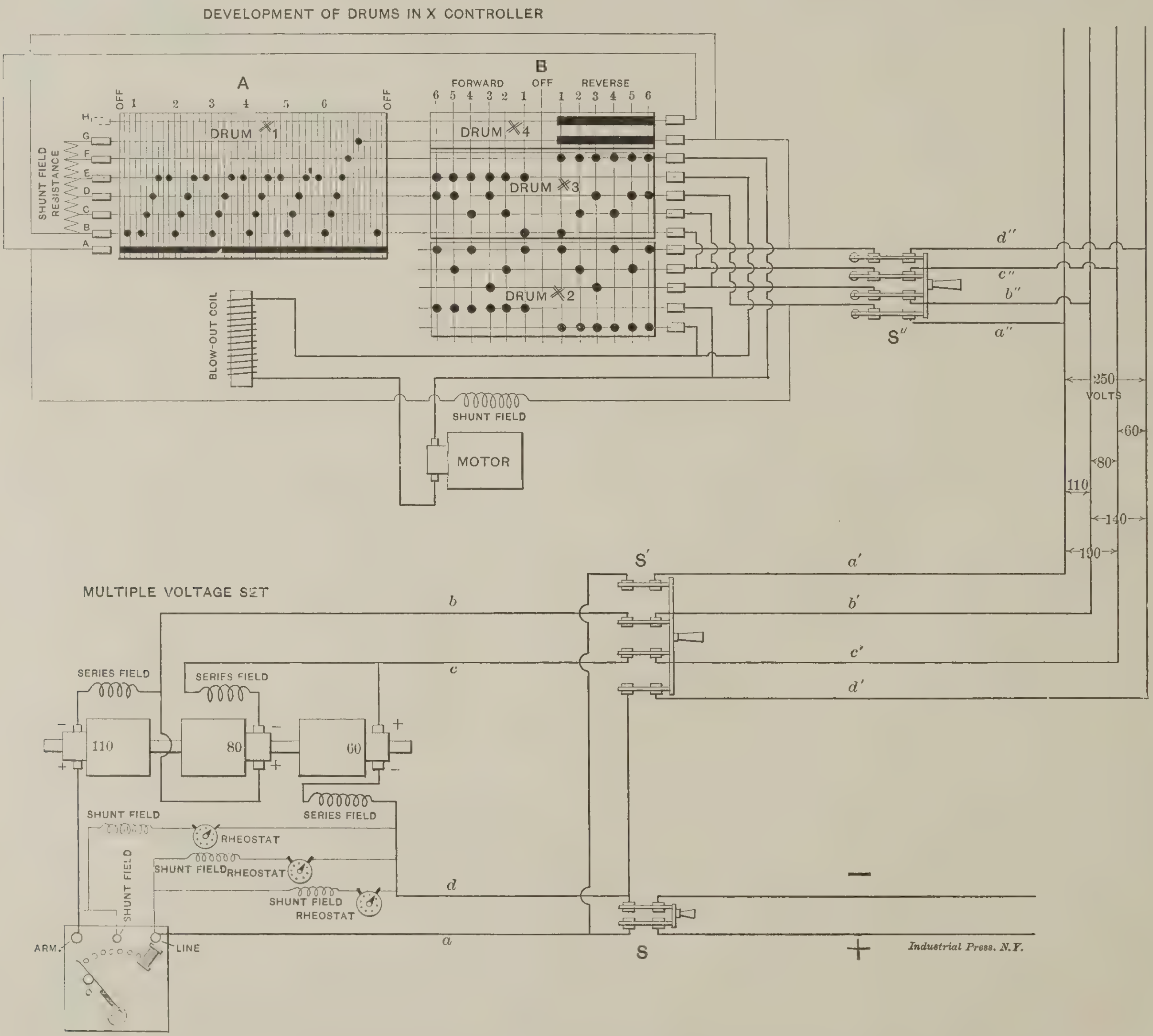


Fig 1 Diagram of Four-wire System of Bullock Electric Mfg. Company.

The four rectangles in the diagram, marked "drums," are metallic plates that encase the cylinders and have raised contacts at the points indicated by black circles and bars. The three drum plates on cylinder *B* are insulated from each other. When the motor is stopped the stationary contacts shown at the right of cylinder *B* rest along the center line of the diagram, so that if the cylinder rotates to the right the motor will be connected so as to rotate in the forward direction; and if it is turned to the left the motor will be connected to revolve in the reverse direction. If the controller handle is turned in the direction to give the motor the forward motion, drum 1 will move to the left, under the stationary contacts drawn at the left; the cylinder *B* will rotate to the right so as to move the contacts on the left side of the drum under the stationary contacts, which it will be remembered rest along the center line of the drums. On the left side of the drums, on cylinder *B*, the second row of contacts from the top on drum 3, and the second row from the bottom on drum 2 will connect with the motor armature terminals. The middle row of contacts on drum 3 will connect with wire *a*″. Wire *b*″ will connect with the middle row of contacts on drum 2 and with the second row from the bottom on drum 3. Wire *c*″ will connect with the second row of contacts from the top on drum 2, and with the bottom row on drum 3. Wire *d*″ will connect with the top row of contacts on drum 2.

From wire *d*″ a shunt connection runs to stationary contact *B*, of cylinder *A*, which contact is connected with one end of the shunt field resistance. From wire *a*″ another shunt connection runs to the shunt field coil of the motor, and thence to stationary contact *A*, of cylinder *A*.

Keeping the foregoing connections in mind it will be seen that when the controller is moved to the first forward step, the motor armature terminals are connected with wires *c*″ *d*″, which give the lowest voltage, and the shunt field circuit will be closed through the stationary contacts *A B* of cylinder *A*, which will be resting on the two lower rows of projections on drum 1. As cylinder *A* is further advanced, stationary contact *C* will ride over the third projection, while contact *B* will pass off the second projection, and thus one section of the shunt field resistance will be cut into the circuit. This will reduce the current through the field coil and increase the motor speed. As cylinder *A* is further advanced, the contacts *D* and *E* will come in contact with drum 1, successively, thereby cutting additional resistance into the shunt field circuit, and further increasing the motor speed. When cylinder *A* reaches the second position, all the field resistance is cut out, stationary contacts *A* and *B* being the only ones in contact with drum 1. At this same instant cylinder *B* advances to the second position and then the armature terminals of the motor are connected with wires *b″ c″*, which give the second voltage, with which the motor speed is a little greater than that obtained with the first voltage and all the resistance cut into the shunt field circuit.

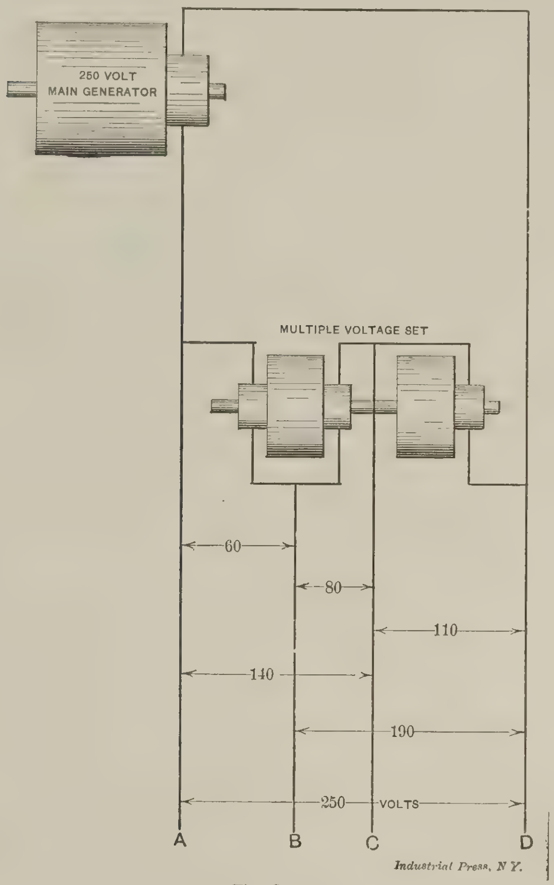


Fig. 2.

The continued advance of the controller toward position 3 causes the *A* cylinder to repeat the operation of cutting the several sections of the shunt field resistance into the circuit, and when the third step is reached, cylinder *B* will change the motor armature connections from wires *b″ c″* to wires *a″ b″*, while cylinder *A* will again cut out the field resistance. In the further movement of the controller the action of cylinder *A* will be a repetition of what has been just explained; that is, after each step is reached the sections of the field resistance are cut into the circuit, and when the next step is reached they are all cut out. The cylinder *B*, in advancing from step to step, simply changes the motor armature connections with the line wires so as to increase the voltage at each step until the highest voltage is reached.

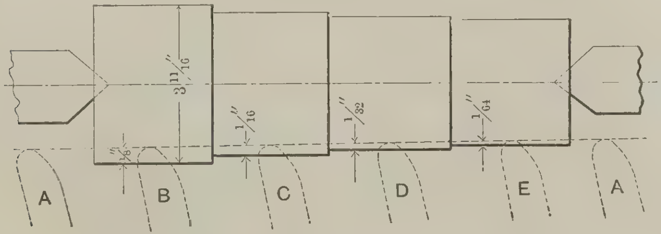


Fig. 6.

Drum 4 does not come into action except when the motor is reversed, and its office is simply to short-circuit the shunt field resistance; so that in the reverse motion the motor can only give six different speeds, but the range of velocities is the same as on the forward motion.

It will be noticed that cylinder *A* does not cut in all the field resistance until the sixth step is reached, so that between the other steps there are three gradations of speed effected by the introduction of resistance, and on the last step there are five. This makes 20 speeds that are obtained by the introduction of resistance in the shunt field circuit, and these added to the six obtained with the different voltages give a total of 26 speed variations.

When the four-wire system is installed in an establishment where there is no electric plant, a generator capable of giving the highest voltage is provided, as illustrated in the diagram, Fig. 2, and the intermediate voltages are obtained by means of the balancer. If an electric plant is already in use, and the voltage is high enough, the balancer connections will be the same as in Fig. 2, but if the E. M. F. of the existing plant is too low, the balancer connections are modified in the manner shown in Fig. 3.

In Figs. 2 and 3 the balancer shown is of the two-armature type, one of these armatures being provided with two separate windings, each one being connected with an independent commutator. As indicated in the diagrams, one of these armature windings develops an E. M. F. of 60 volts, and the other 80 volts, and as both windings are connected in series, through the commutator brushes, their combined voltage is 140.

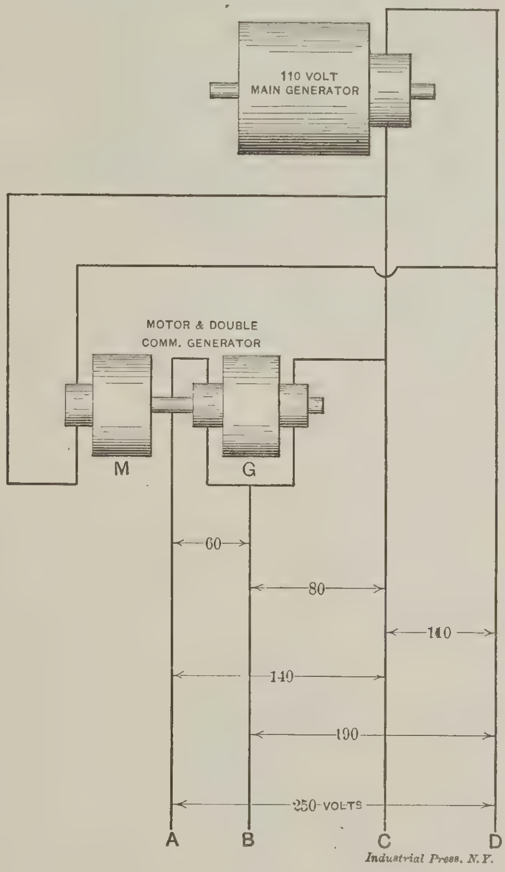


Fig. 3.

The action of the balancer in Fig. 3 is not the same as that of Fig. 2. The latter is a true balancer, and both armatures can act as motors or generators, as the case may require. In Fig. 3, however, the single-commutator machine acts at all times as a motor, and its office is to furnish the necessary power to drive the double-commutator machine which acts as a generator. If there are no motors connected with line *A*, no current will be generated in the 60-volt circuit of the armature. If there are no motors connected with line *B*, the current drawn from line *A* will pass through both the windings of *G*. If there are no motors connected with either line *A* or line *B*, no current will be generated by *G*. In any case, however, motor *M* will furnish all the power necessary to drive *G*. From this it can be seen that as *M* simply provides power to drive *G* it may be replaced by a steam engine, or by a belt connection with a main line of shafting, or any other source of power.

If the generator is large enough to furnish all the current required to operate the motors a motor generator set as shown in Fig. 3 can be used; but when the main generator is not large enough, then power from some other source must be provided to drive *G*, and in such a case the latter will be simply a double-current generator added to the generator already in use, connected with the latter in the way shown in the diagram, so as to form a four-wire distributing system.

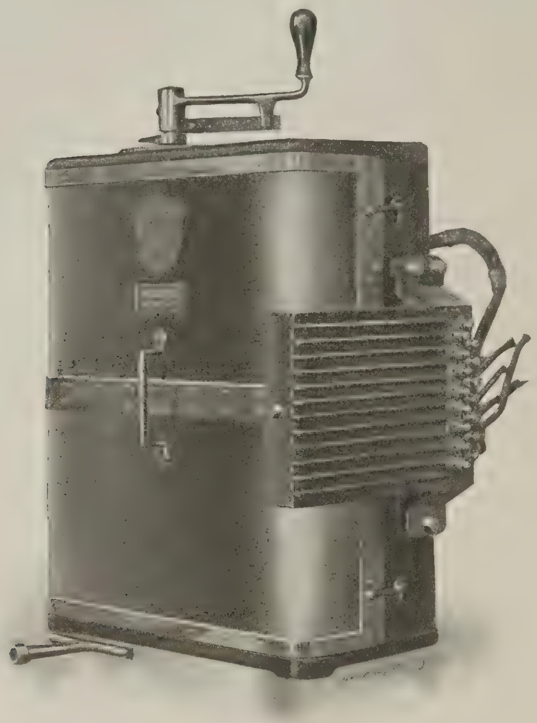


Fig. 4.

When a balancer is connected in the way shown in Fig. 2, the sum of the voltages of the armatures cannot be greater than that of the main generator, but will always be somewhat less, the difference depending on the amount of current passing through the circuit; but when a motor generator set is connected in the way shown in Fig. 3, the voltages developed in the generator armature may be as much in excess of the main generator E. M. F. as may be desired. Hence this arrangement is advantageous in cases where a 110-volt plant is in service for lighting purposes, and it is desired to obtain higher voltages for the operation of motors.

The arrangement of Fig. 3 can be used with a three-wire system as well as with the four-wire. As can be readily seen, if generator *G* has a single armature winding with one commutator, one of the brushes can be connected with *B*, and the other with *C*, just as in the diagram. The only difference between a three-wire system arranged according to Fig. 3, and a four-wire system is that with the former the voltage cannot be increased much. With the four-wire system, if the main generator E. M. F. is 110 volts, the maximum voltage can be 250 if the intermediate voltages are as indicated in Fig. 3; but with a three-wire system the maximum would be 190 volts. As a matter of fact it would be less, because 80 volts would be too high for the low E. M. F., which should be 60 or 70, so that the maximum would be 170 or 180.

The controller used with the four-wire system is shown in Fig. 4. The handle by which it is operated is mounted on the shaft of cylinder *A*, Fig. 1. The shunt field resistance is attached to one side of the controller. When the machine driven by the motor is of such a type that the controller can be conveniently operated by means of the handle on top, this arrangement is used, but in cases where it is necessary to operate the controller from a distance, suitable connecting shafts or levers are provided. Fig. 5 shows the way in which the controller is arranged on large lathes. The shaft running under the tool carriage is an extension of the shaft of cylinder *A*. On this shaft slides a feathered bevel gear that meshes into another gear on the upright shaft seen at the right side of the carriage, and by means of the handle at the top of this shaft the workman can operate the controller wherever the carriage may be.

One decided advantage of systems like the foregoing, in which the variations in speed are obtained by changing the field strength, or the voltage acting upon the armature, or both, is that the regulating qualities of the motor are not destroyed, so that at whatever speed the motor may be set it will maintain this constant without any regard to changes in the amount of work put upon it. With the rheostatic method of control, in which speed reduction is obtained by introducing resistance in the armature circuit, the regulating property of the motor is impaired, so that if it is set for a given velocity, it will accelerate if the load is reduced, and will slow down if the load is increased. As was shown in a previous article, this defect of the rheostatic method renders it practically useless for cases where the work is intermittent. An experiment tried by the Bullock company, which is illustrated in the diagram, Fig. 6, shows that the system is objectionable not only for intermittent work, but even for cases where the load is liable to vary to a considerable extent. A large portion of the work done on lathes for example, is of a kind that renders the load variable, as the size of the cut changes within wide limits. This is the case in taking the first cut on castings and most forged work. In all work of this kind if the speed is adjusted by introducing resistance in the armature circuit, the motor will speed up when the cut is light and will slow down when the cut is heavy. Fig. 6 shows a piece of work in the lathe with the tool taking a light cut when in position *E*, and increasing by steps through the positions *D C B*. By actual test it was found that if the motor was adjusted to run at the proper speed when the tool was in position *E*, it would slow down about twenty-five per cent. when the tool reached position *D*, and on reaching *C*, the motor would stop. The result of this test is shown in Table 1. The extent to which the speed would increase if the motor were adjusted to give the proper speed with the tool in position *B* cannot be very well ascertained experimentally as the velocity would be so great that the tool would be burned away. Table 2 shows what the velocities would be as determined by calculation.

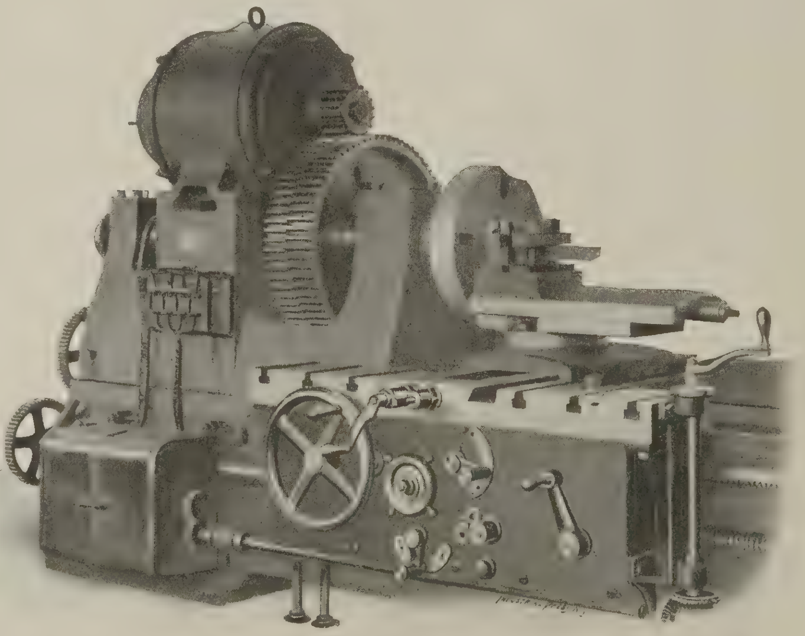


Fig. 5.

From the foregoing it will be seen that any system of variable speed motor control to be satisfactory so far as velocity is concerned, must eliminate entirely the introduction of resistance in the armature circuit, except in passing from one running speed to another.

A NEW FOUR-WHEEL DRIVE FREIGHT TRUCK.

CORNEIL RIDDERHOF.

In MACHINERY for September, 1903, I called attention to the Holson couple-gear motor as being an interesting example of good mechanical arrangement for reducing friction and producing a power transmission of high efficiency. Figs. 1 and 2, reproduced from that issue, show respectively a side view of the assembled motor as used in the hub of a light vehicle and an end view with one of the bevel gears removed. It will be noticed that the motor shaft has a pinion at each end, applying power to the driven member at two diametrically opposite points and dividing the pressure due to driving between both bearings of the motor. Some are bound to call this arrangement a new mechanical motion. Whether this be strictly true or not, it is novel and exceedingly useful and will undoubtedly be applied to many varied purposes.

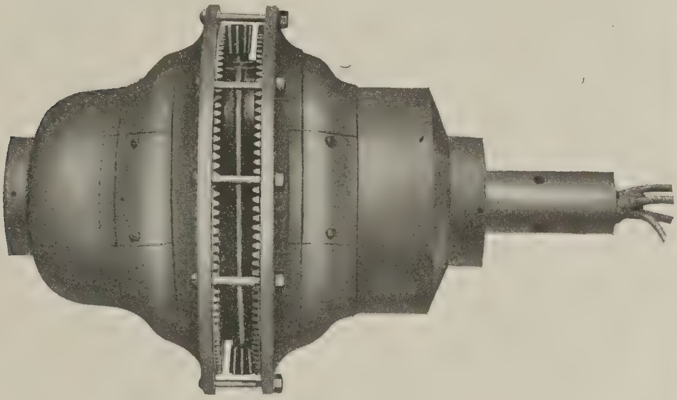


Fig. 1. Side View of Holson Motor in Wheel Hub.

The three-ton freight truck, which it is the purpose of this article to briefly describe, shows one application of the device and I believe it is to such uses as this that it will be most frequently applied. The wheels having the motors within themselves there is nothing to hinder using all four wheels for traction, and this has been done. Fig. 3 is a general view of the truck and incidentally shows that in a vehicle equipped with these motors all wheels can be used for steering without adding complications. This renders the machine capable of being handled in confined places with an ease that must be seen to be fully appreciated and compared with which the complicated bevel gear four-wheel drives that have been used in vehicles with a "central" power plant seem exceedingly crude and impracticable.

Fig. 4 shows one of the wheels with tire and rim removed and shows how near the periphery of the wheel the propelling power is applied. The large bevel gears are 28 inches diameter, 2 inches face, and have 224 teeth, 8 pitch. The pinions on the motor shaft have 9 teeth; giving a reduction of nearly 25 to one, and an equalizing device insures the driving being divided equally between both pinions. The four motors are two horse power each and are handled through a drum controller similar to those used in street cars, and brakes on all wheels render the machine safe on any grade. The batteries are 42 exide cells, type M V 15, with a capacity of 200 ampere-hours, and are carried below the platform.

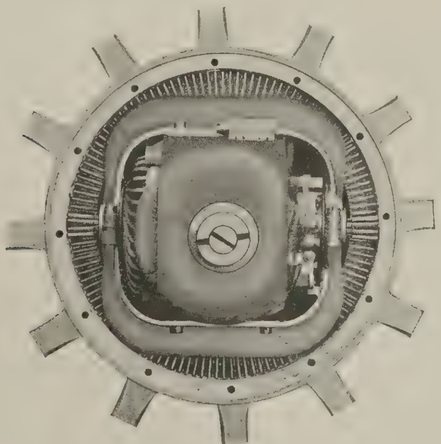


Fig. 2. End View of Holson Motor.

Watching the machine climbing grades with a 7,000-pound load some time since and being informed of the meter readings, I expressed some doubt as to their accuracy, and accordingly a still more severe test was arranged at which I could satisfy myself as to this. An accurate Weston ammeter was secured and connected. Having the instrument on my lap and a note book beside me made it quite convenient to note and record the readings, and considering the grades, the condition of some of the pavements and the heavy load, I think the performance of the machine quite remarkable. The machine was tried on a 10 per cent. grade and on a very rough cobblestone pavement. Further up the hill (which is four blocks long) the excessive weight caused the front wheels to crush through the pavement but, plowing a deep furrow and scattering the stones right and left, it kept on moving, though slowly. The net weight of the truck is 7,725 pounds, and this added to the load, 9,000 pounds, makes 16,725 pounds; no small matter to push up a grade, and considering that it only took 95 amperes at 80

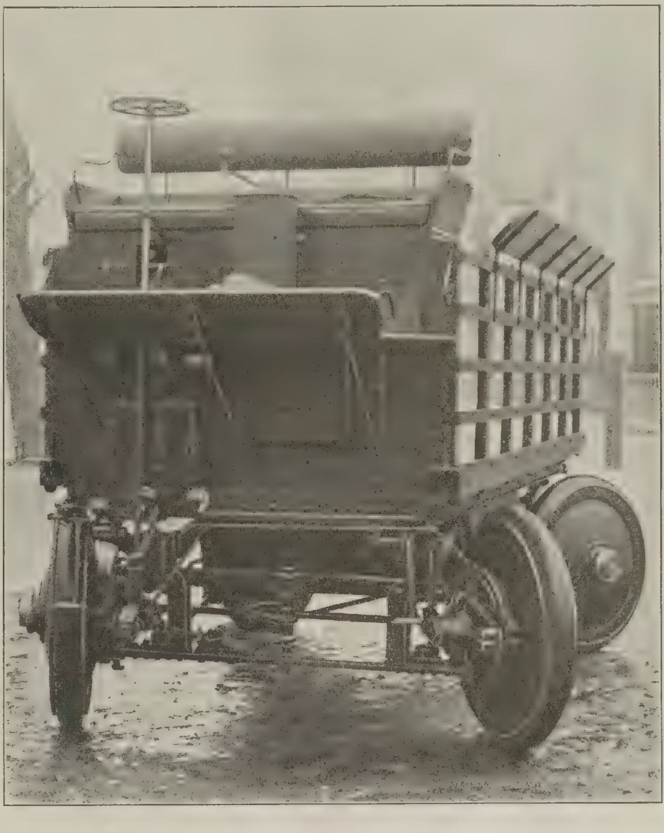


Fig. 3. Three-ton Truck with four Motors in Wheels.

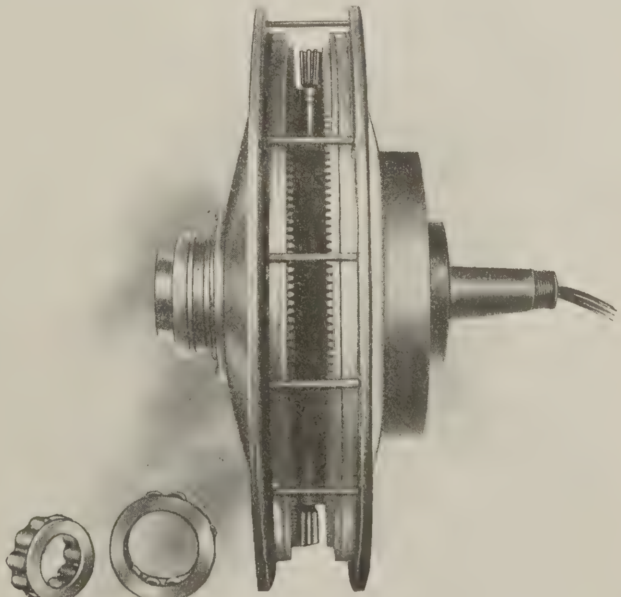


Fig. 4. One of the Wheels of the Three-ton Truck with Tire Removed.

volts I think the performance quite remarkable. This would indicate $\frac{95 \times 80}{746} = 10.18$ horse power, and assuming an efficiency of the motor of 74 per cent., and of the transmission of 96 per cent, we have $10.18 \times .74 \times .96 = 7.23$ horse power actually expended in pushing this enormous weight up that hill.

Of course speed is an important consideration here, and the truck under this abnormal load (being designed, as before stated, for three tons) moved necessarily slowly, but even at a speed of 1½ miles per hour the actual power, neglecting all resistances excepting that due to elevating this weight, equals

$$\frac{5,280 \times 16,725 \times 1.5}{33,000 \times 60 \times 10} = 6.69 \text{ horse power.}$$

The exact speed could not be determined as the motors were connected in series and the speed varied continually with changes in resistance due to grade and condition of pavement. With the same load on a level brick pavement the readings averaged 27 amperes at 78 volts.

Although this is the first truck built it appears to be entirely free from those little features of poor design usually so conspicuous in first attempts and I cannot but admire its designer, Mr. Karston Knudsen, of Chicago, for this remarkable vehicle. The steering arrangement is very complete and is worthy of notice. The vehicle may be steered with the front wheels alone; with all four wheels, as shown in Fig. 3; and also when necessary all four wheels may be turned in unison and in the same direction, giving the vehicle a motion in a straight line at an angle to the center line of the body, an action aptly christened the "dog steer" by Mr. Knudsen.

* * *

A SPECIOUS PLEA FOR AMERICAN SHOP SECRETIVENESS.

A gentleman from Philadelphia writes a remarkable letter to *American Industries*, signing it "Self-Preservation," in which he demands in no uncertain manner that visiting foreigners be denied the privilege of visiting American shops. He sees in this generally extended courtesy the means of our industrial undoing, and asks all manufacturers to join hands in a policy of shop exclusion to these polite visitors:

> "The growing prominence and popularity of American-made goods in foreign markets has excited the envy of foreign manufacturers to such a degree that it is a well-known fact that they have within the last few years engaged very largely in the business of copying them, and although in most cases the copies are very poor imitations of American products, the low prices at which they are able to sell them has in many instances forced the American maker out of the market, or nearly so, and this, too, in lines that were not known in these markets until introduced and pushed to the front by him.
>
> "If these pirates were only satisfied with making inferior imitations, it would not be so bad, as we could rest assured that the quality of our goods would ultimately give us back our market; but this is not the case. Finding that their inferior productions have not succeeded in many cases in forcing out the American goods, they are sending their representatives to the United States in droves to study our machinery, processes and shop methods, with the end in view of being able to equal our quality of finish as well as imitate our patterns and designs.
>
> "They come to us with plausible stories and polite requests to be shown through our factories, always flattering us with complimentary remarks upon our wonderful growth and enterprise as a great manufacturing nation, and expressing a desire to see how we do it; and this is just the point. After we have in our easy good-natured American fashion shown them *how we do it*, they take the next steamer home and at once proceed to do likewise.
>
> "A case in point as an illustration of their methods. The goods of a certain manufacturer are now imitated in Germany, Sweden and England, but owing to the inferior quality of the imitation they have not succeeded in forcing out the American product; but the Swedish concern, more enterprising than the others, last year sent a diplomatic representative over here to find out how to produce American quality and finish, but the home manufacturer was fortunate enough to discover his mission and of course the gentleman did not gain access to the factory, though he made strenuous efforts to do so. And now we understand that a son of the proprietor of the concern is in the country to try his hand at it. This is only one of many instances, and in many cases they succeed in getting what they are after.
>
> "Another favorite method is to send a man over here to secure employment in a factory manufacturing a line they are copying, and the more menial the position he secures, the better for his purpose, as a sweeper or common laborer who has access to all parts of the plant is never suspected of ulterior motives; but while he is working for his American employer for $1.50 per day he is sitting up nights in his boarding house, making notes and drawings.
>
> "This year, with the World's Fair in St. Louis, is going to be especially prolific in bringing these people to our shores, with their polite requests as foreign visitors to our land of liberty, to be shown through our plants. We cannot too strongly urge the American manufacturer, if he desires to retain the supremacy that he has achieved in the export trade, to politely but *firmly* decline the honor of showing these distinguished foreigners, one and all, through his plant. They know too much already and are learning more every day, and will continue to learn in spite of all we can do; but to give them the information which we have spent years in gaining, freely, as we would a cup of water, is simply suicidal."

Whether a manufacturer shall extend the privilege of inspecting his shop methods to visitors, whether foreign or of the home-grown variety, must be decided individually and chiefly by his sense of hospitality. There are industries in which the advent of a visitor always creates a certain degree of confusion and lost time on the part of the employes (especially if of the female gender), and it is part of a good business policy to generally exclude visitors. But the exclusion of visitors should never be made the policy with the aim of maintaining supremacy. Manufacturing supremacy, in the general sense at least, is not maintained in this manner. We should be very sorry to see American industries pin their faith on such an exploded theory as this. The man who imitates you is never anything but an imitator and so long as you are progressive you can let him imitate safely. In fact it is better to have imitators, for an imitator can rarely or never become a successful competitor. Of course if our peculiar tariff laws are made to work to our undoing that is another matter, and is one that the foreign manufacturer may properly take advantage of.

* * *

PROCESS FOR HARDENING CAST IRON.

A patent has been granted for a process for hardening cast iron, whether in the rough or after machining. It consists essentially of a bath having high heat conductivity, the process of hardening consisting of heating the cast iron pieces and dipping them in the bath in the same manner as pursued in hardening steel. The patent claim reads in part as follows:

"The castings which are to be treated may be completely finished as regards machine work before they are hardened. The casting is first heated to a 'cherry-red' heat; it is then dipped in a bath which consists of a practically anhydrous acid of high heat-conducting power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of one or more of the heavy metals or their compounds—such, for example, as arsenic or the like. The preferable ingredients of the bath are sulphuric acid of a specific gravity of approximately 1.84 and red arsenic in the proportions of ¾ pound of red arsenic crystals to 1 gallon of sulphuric acid. The castings may be either suddenly dipped in the afore-mentioned mixture and then taken out and cooled in water, or they may be left in the bath until cool. We find, however, that by dipping the castings in the bath and holding them there for a time, which varies according to the size of the castings, and then completely cooling in water, is quite as satisfactory and produces a material which is just as hard as if the castings were allowed to remain in the bath until cool, and the former method is preferable if a large number of castings are to be hardened, as the bath is thus prevented from becoming overheated. In preparing the bath when sulphuric acid and red arsenic are used, we find that better results are obtained when the crystals are added to the sulphuric acid and the bath is allowed to stand for about a week before using, the reason probably being that the bath becomes more saturated with arsenic compound when the dissolved red arsenic has been long in the sulphuric acid.

"It is found that in castings of comparatively large dimensions the hardening extends completely through the material, and thus the results obtained are far preferable to those obtained by what is known as 'casehardening.' The change which takes place in the metal is in the nature of a molecular rearrangement or recrystallization coincident with an increase in the combined carbon at the expense of the graphitic carbon, and in this change lies the difference between the results by our bath and ordinary casehardening processes, in which a certain portion of the carbon contained in the materials of the bath is actually given up to the metal.

"It is found that the more rapid the cooling of the metal the harder it will become. For this reason the bath must be of high heat-conducting power, and this requirement is obtained by the use of the ingredients above referred to. The bath must further be practically free from water, as it is found that when the acid contains water in any considerable quantities a steam-cushion is formed between the acid and the metal, which prevents their coming in contact, with the result that the cooling is less rapid, and the iron is consequently not so hard. By having one or more of the heavy metals or their compounds dissolved in the acid the heat-conducting and heat-absorbing powers of the bath are considerably increased."

* * *

THE WORKS OF THE STANDARD PLUNGER ELEVATOR COMPANY.

W. A. WATERMAN.

W. A. Waterman.

The new plant of the Standard Plunger Elevator Company, Worcester, Mass. (Janesville Station), is located on the Boston & Albany Railroad and the Worcester and Southbridge Railway, 3½ miles from the center of the city. The company was organized by Mr. Fred A. Jones, Worcester, Mass., who has been identified with the plunger elevator business for the past twenty years. When the company was formed in September, 1902, they did not have a factory nor the land to build one on, but on the 27th of April, 1903, the largest and best equipped factory in the world for manufacturing plunger elevators was started up in full, with a pay roll of 200 men; and within 15 months from the time the company started, orders had been secured for over 130 elevators, which when installed, were to comprise some of the best and most complete elevator plants that had ever been installed. Recently one of the largest elevator contracts ever let has been secured from John Wanamaker, for 110 elevators. These are for the new Wanamaker stores in New York and Philadelphia. Fifty-two of these elevators are to have long runs for passenger cars, 42 having runs of 184 feet and 10 of 253 feet. Other important contracts for large office buildings in New York, Pittsburg and elsewhere, which call for passenger equipment with long runs, in one building to a height of 282 feet, are further indications of the extent to which the plunger system for elevators is being adopted for high-speed passenger service where safety of life and limb is the first requisite.

The officers of the Standard Plunger Elevator Co. are: W. H. Woodin, New York, President; John Sherman, Hoyt, N. Y., Treasurer; Fred A. Jones, Worcester, Mass., General Manager; Thure Larsson, Worcester, Mass., Chief Engineer, and Edward E. Chase, Worcester, Mass., Purchasing Agent. The main office of the company is at No. 1 Broadway, New York.

The factory is 350 feet long, 150 feet wide and contains a floor space of 80,000 square feet, which includes galleries that are used for a stock room and pattern factory. There is land enough available on the present lot to extend the building to a length of 600 feet. The structure has a very high monitor, so as to let in all the light possible; it is about 55 feet from the floor to the top of the monitor. A handsome building adjacent to the factory contains the Worcester offices of the Company and also drafting rooms, where there are eighteen draftsmen employed at present. There is a separate power house of brick, with limestone trimmings, having floors in the engine room, boiler house and basement of grouting covered with Portland cement. The roof is of structural steel covered with slate, and the whole constitutes a thoroughly fireproof building. The only connection between the power house and the factory, is by a 36-foot square tunnel, waterproof, where all the steam pipes, water pipes and electric cables are laid.

In the power house there are two fire-tube boilers made by the Worcester Boiler Works, operating under a pressure of 150 pounds per square inch. Power is furnished by two 150 H. P. Westinghouse automatic compound engines direct-connected to generators, which furnish the electric power for the factory. The engines are so arranged that they can be worked in separate units or together, as the case may be. No. 1 engine can be united with No. 1 switchboard, or No. 2 switchboard and No. 2 engine can be united with No. 1 or No. 2 switchboard. This arrangement was made so that the engineer can change from No. 1 engine to No. 2 engine, or No. 2 to No. 1 without stopping the engine, which makes it very convenient. After the electric current has passed through the cables to the switchboard, it is passed along to another switchboard and from there it is turned into a Bullock multiple voltage balancer, which enables currents to be obtained of six different voltages, which are as follows: 60, 80, 110, 140, 190, 250. The Bullock four-wire system is used. After the balancer has been started, the current passes through the cables to the basement, then through the waterproof tunnel, up into the factory to the distributing switchboard, where it is turned into any part of the factory and office. The size of the cables that run from the engines to the factory switchboard is 1,000,000 C. M. for the outside wires, and 500,000 C. M. for the two inside wires. The current for the lighting system passes through a balancer in the engine room before it goes to the factory so the voltage can be reduced from 250 to 125, in order to use the Manhattan arc light, which has a voltage of 125. There are about 55 arc lights and these in connection with about 200 incandescent lights, make the factory at night almost as light as day.

In Fig. 1 is an interior view of the factory, looking from the main entrance toward the loading platform and railroad track. It also shows the five-ton high-speed Shaw electric crane. The work of handling elevator material in the past has been done by means of manual labor and by the use of this crane the company can save about fifteen ($15) dollars per day in helpers' wages, to say nothing of the saving of time, which is a very important factor in a manufacturing plant.

The crane has a span of 60 feet, a hoist of 30 feet and can run 350 feet in exactly 60 seconds. It has a test capacity of 15,000 pounds, yet it has lifted a load of 40,000 pounds. This load was not intended to be lifted with the crane, but the chains got hooked to one end of the body of a car, and before anyone realized what had happened, the car and load were hanging in mid-air. The load weighed 70,000 pounds and the car 30,000 pounds. To further show what the crane can do, I will state that I have seen a load of structural iron consisting of 3x3-inch, 3x4-inch, and 4x5-inch angles; also 6, 8, 10 and 12-inch I-beams, making a total weight of 69,000 pounds, unloaded and carried 150 feet in just three hours with the help of two men; also 43 lengths of 10-inch extra heavy pipe unloaded and carried 300 feet in 55 minutes with two men.

In looking at Fig. 1, the method of handling pipe can be easily understood. The view also shows the construction of the factory, the crane posts and also the stock room where all the stock is kept stored. The construction of the whole building can be seen showing the clearstory and the monitor roof; the timber is all southern hard pine.

Fig. 2 shows a view, looking from the railroad track toward

W. A. Waterman, superintendent of the Standard Plunger Elevator Co., Worcester, Mass., was born at North Appleton, Me., in 1871. He served an apprenticeship with the Rhode Island Locomotive Works, Providence, R. I., and has since held positions successively as machinist, assistant foreman, general foreman and superintendent, and has been employed by the Builders' Iron Foundry, Providence, the Providence Engineering Works, and the Plunger Elevator Co., Worcester, previous to going with his present company. He writes, "I had about three years' common schooling and entered my apprenticeship at the age of 14 years. Before that I lived on a large farm. Seventy-five per cent. of my education has been obtained since my apprenticeship by hard study, day and night."

the main entrance; it also shows about 4,000 feet of cylinder and plunger pipe in course of construction. In the center of the floor is a line of pipe which is a part of a cylinder, that is 240 feet long, and that has been tested at 600 pounds pressure per square inch, and is all ready for shipment.

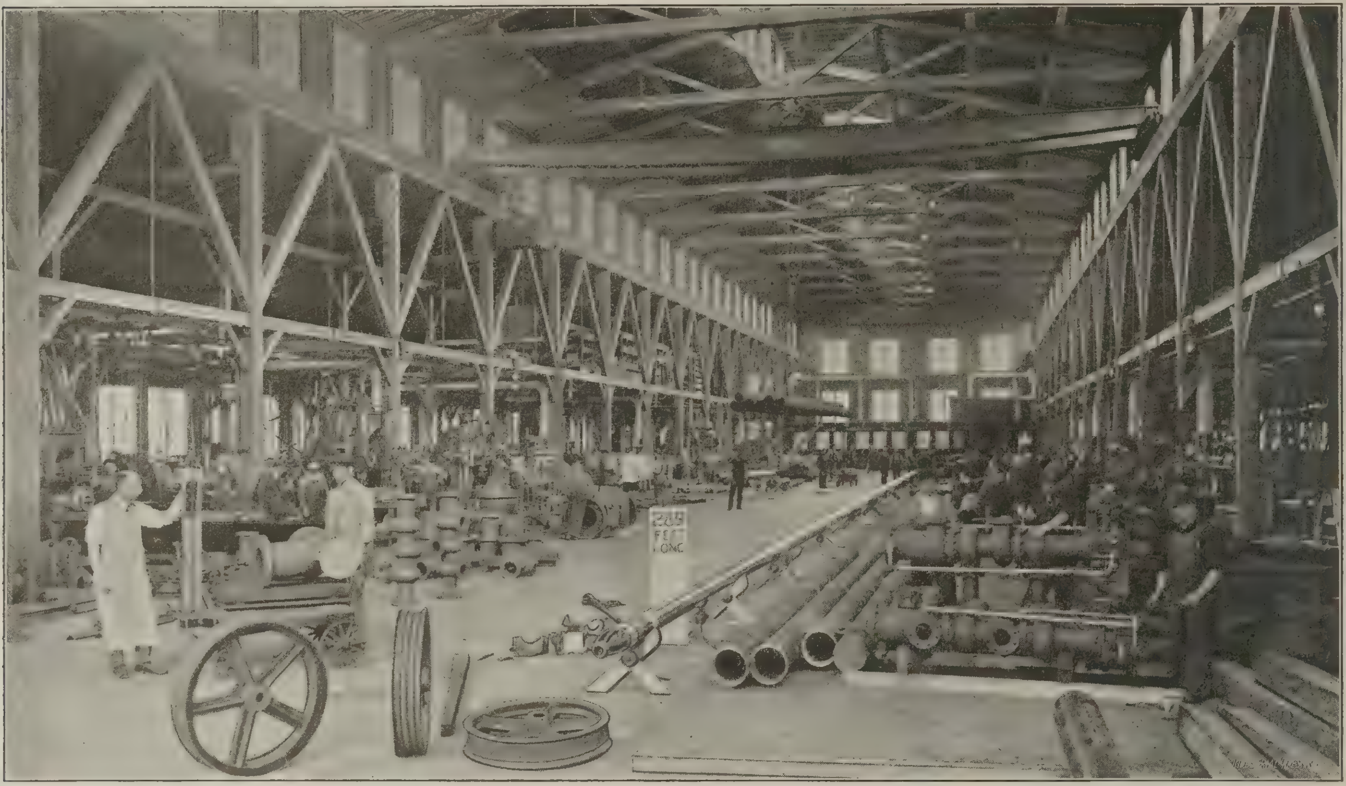


Fig. 1. Interior of Machine Shop of the Standard Plunger Elevator Company. An Elevator Plunger is lined up on the Floor.

Fig. 4 shows a hydraulic, pipe-straightening machine, designed by our chief engineer, Mr. Thure Larsson and built in our factory. Two of these are used to straighten the cylinder and plunger pipe. The cylinder pipe is straightened so it will not run out more than 1-16-inch when rotated on centers and the plunger pipe is straightened so it will run within 1-32-inch of true. The reason for straightening the plunger pipe so carefully is because it has to be turned and in order to have the pipe clean up, free from scale, without turning off any more stock than is absolutely necessary, it must be straight to start with.

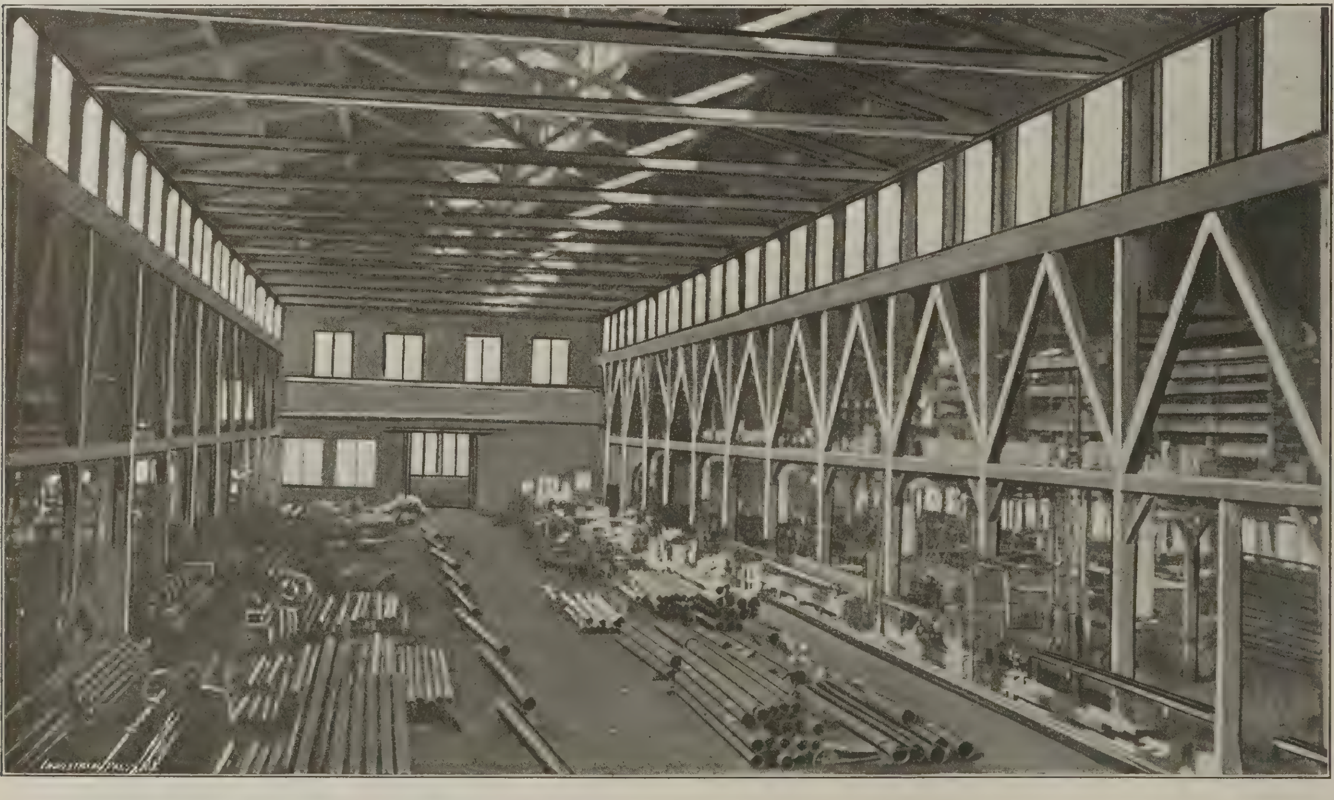


Fig. 2. The Opposite End of the Shop, showing Cylinder and Plunger Pipe.

The hydraulic straighteners are motor driven and the operator can handle the machines to much better advantage than if they were driven by belt. The electric control is placed in front of the cylinder to enable the operator to run the machine and straighten the pipe without changing his position. It requires but two men to straighten from 100 to 175 feet of 6- 7- or 8-inch plunger pipe in ten hours.

In connection with the machines is an intensifier that is used to increase the water pressure from 130 pounds (city pressure) to 2,200 pounds pressure per square inch. The cylinder base is 15 inches diameter and the city pressure is not enough to straighten the pipe, so the high pressure has to be used. Sometimes it takes 2,200 pounds pressure per square inch to do the work, which means a pressure of 190 tons to straighten 12-inch extra heavy plunger pipe. The intensifier is operated by a lever valve, which is placed on top of the cylinder of the machine, and is opened and closed by a lever that hangs down from the valve in front of the operator, so that he can operate both the machine and intensifier without any loss of time.

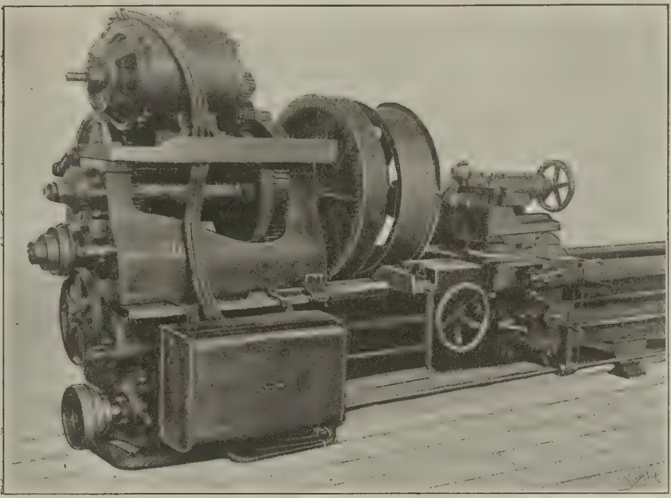


Fig. 3. Motor-equipped Lathe

On the same side of the shop with the hydraulic straightening machines is a group of machine tools consisting of boring mills, planers, lathes and drills. Part of these tools are driven from a line shaft 204 feet long, running at 150 revolutions per minute, power for which is furnished by a 50 H. P. Bullock motor. The larger tools, such as a radial drill and boring mills are independently driven by motors by means of special gearing.

On the opposite side of the shop is the pattern and carpenter shop where eight patternmakers are regularly employed upon patterns for elevator parts. The machinery for this work is of the best and latest design, some of which was made by Whitterby Rug Richardson, Worcester, Mass., and other machines by S. A. Wood, Boston, Mass. We do all our own woodwork, so that we know the best material has been used that the market affords.

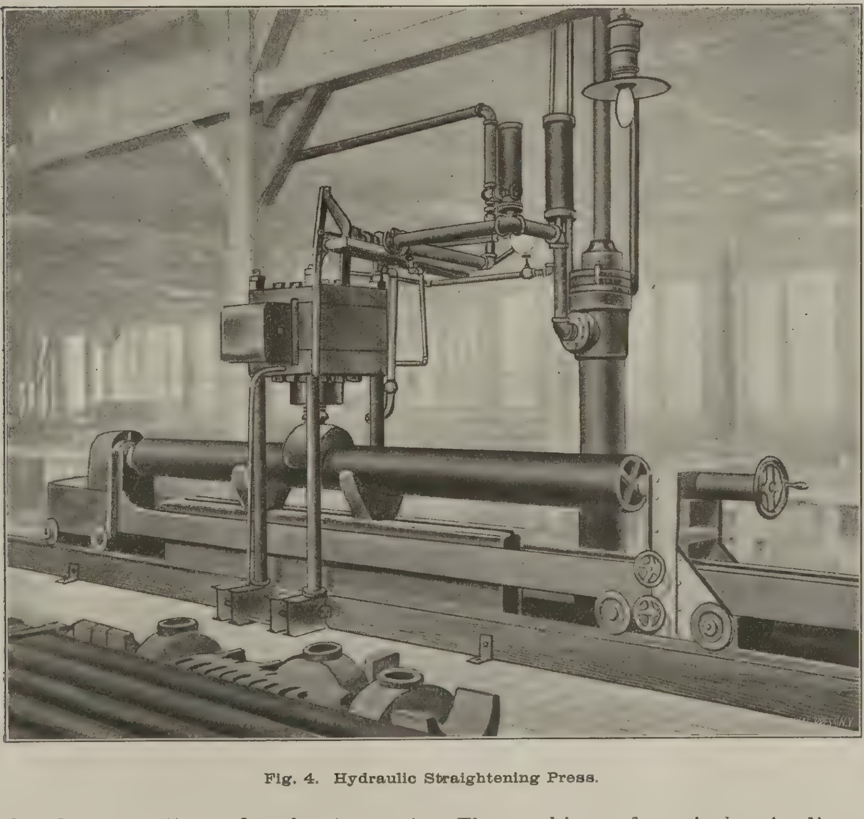


Fig. 4. Hydraulic Straightening Press.

Before closing my description of the factory, I would like to call the attention of the readers of MACHINERY (who include not only machinists, but also superintendents, managers and owners of manufacturing plants) to the application of the multiple-voltage system to machine tool driving.

As stated, our factory is equipped with the Bullock multiple voltage system and its advantage over the belt drive for machine tools has proven to be far above expectations. When the motor drive was first talked of we did not anticipate that it would result in a large increase in the output of the various tools to which it was to be applied. It was considered mainly because we did not want any overhead works over the machines on the main floor, which would have interfered with the crane. So we made a careful investigation of the subject and decided to adopt the Bullock system throughout the whole factory. While we finally put in more motor-driven tools than was first intended, our only wish now is that 50 per cent. more of our tools which are not equipped with independent motors had been so equipped at the start, and I must say in justice to the multiple voltage system that our motor-driven lathes will do 50 per cent. more work than belt-driven lathes can possibly accomplish.

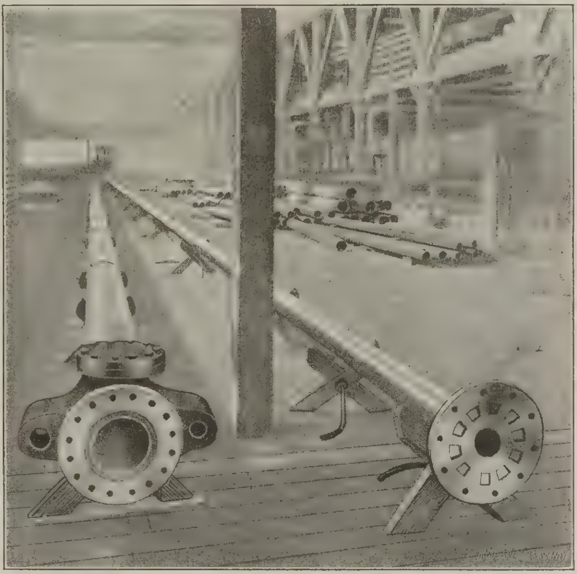


Fig. 5. A 250-foot Plunger and Cylinder for same.

Fig. 3 shows a 38 x 22-inch Fish lathe, that was changed over from a belt drive to motor drive. This has a 15 H. P. Bullock motor, with six different speeds, which gives 18 speeds to the lathe instead of 15 by belt, and the operator can get six separate speeds without leaving the carriage or changing his position, by simply turning off the controller handle, when the electric current ceases, thereby causing the machine to stop. To show the advantage of a motor drive on this lathe, I will mention a job that has just been completed. We had three cast iron cylinders, 18 inches diameter and 12 feet long to bore out for a contract in Philadelphia, and when the casting was made in the foundry, they made the core 15¾ inches diameter, so that we had 2¼ inches to bore out. We put in a boring bar 9 inches in diameter with a traveling head 15 inches in diameter with six tools set so as to bore the hole 17¾ inches in diameter. We set the feed at 2-10 inch to a revolution and it went through the whole length without the least trouble. The cutting speed was 25 feet a minute, but the principal point I wish to make plain is this: That when the test instruments were applied to this motor to see how much power was being consumed, they showed that we were using 9 horse power, whereas the maximum power of the same lathe with a 5-inch double belt was only 6 horse power. This, therefore, goes to show that a 5-inch double belt would not have driven the lathe with the amount of stock being removed, and that we should have been just twice as long in boring these cylinders.

We also do work in a Saunders pipe threading machine with an 8 horse-power motor, that the belt drive could not begin to accomplish. Our F. E. Reed plunger turning lathes with motor drive are doing from 10 to 50 per cent. more work than the belt driven lathes can do with the same operator working on each. In fact, it will take more space than can be spared to write all the results obtainable from our motor driven machines, supplied with the Bullock multiple system. If I were to install the equipment in another factory I should put motor drives on all lathes over 20 inches swing, all milling machines above No. 3, all vertical mills and in fact all machines where heavy work has to be done.

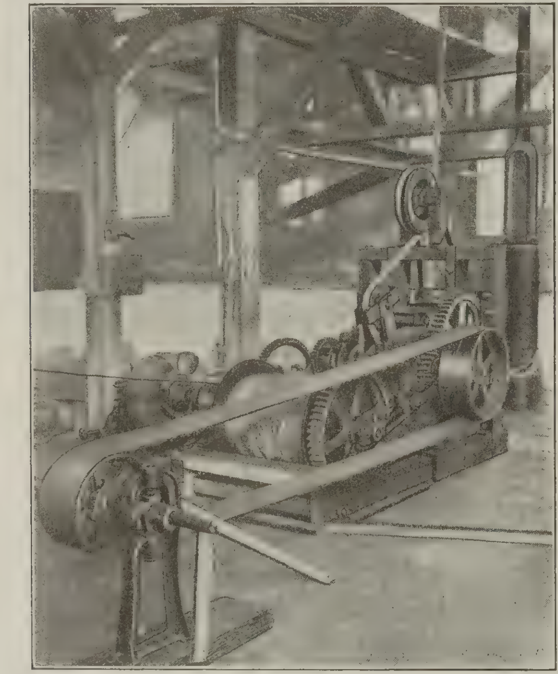


Fig. 6. Jump-drill Machine for Drilling Holes for Elevator Cylinders.

I wish to say a few words about the product that is being manufactured at this plant, although I cannot undertake to relate all the good points of plunger elevators. Everybody, of course, knows what an elevator is for, but I am sure that some readers of this paper do not appreciate why we believe the plunger type is the best type of elevator to have. I will venture the prediction that an elevator suspended by a cable will in 25 years be a thing of ancient history and that the elevator that is pushed from the bottom and cannot fall and kill people will be in use in all buildings where the owners are looking, first, for the safety of the people, second, for speed and durability and third for economical running of the elevator plant.

The first thing to be considered in connection with an elevator is, or should be, the safety of the occupants. When people wish to be carried to any distance above the street floor they like very much to know that they can go up or down with perfect safety. If they are not assured of this they will not go your way.

The second essential thing is the speed and durability. The speed, or what may be called the rapid transit of an elevator, is a factor that must be given due consideration, but the durability of an elevator must be given extra consideration because when a company put in an elevator plant, they do not want to be repairing their elevators ten months out of twelve. I know of one instance where it cost a company $2,000 a year to keep four electric elevators (cable) in repair. Very often three of the four would be out of order for three days at a time, and this particular case is only one of hundreds where cable elevators have proven to be an expensive proposition. When cables have to be replaced, it costs about $1,500 for an 8- to 10-story elevator.

The third essential, the economical running of the elevator, is looked into more seriously, perhaps, by a purchaser, than any other one thing. Our records show that it does not cost over fifty dollars a year to keep an elevator of the plunger type in repair, and I have known of many "Standard Plunger Elevators" that do not cost the owners $20 a year for repairs. The water costs very little, for it is used over and over again until it evaporates or whatever may leak out in the pit-pan. Sometimes the water in the supply or what may be called the discharge tank, will last for two months before it will need to be filled from the city main.

We have not yet been able to determine what the limit is for the successful operation of plunger elevators in high buildings. One that we have installed with a 300-foot run works as well, if not better, than those with a run of 100 or 150 feet. In Fig. 5 is a 6½-inch plunger, 250 feet long, and a 10-inch cylinder for the same, which are part of a contract for the Waldorf-Astoria Hotel, New York City, where there are 17 cable elevators that are to be replaced by Standard Plunger elevators. On the shop floor, Fig. 1, is a plunger 7½ inches in diameter and 289 feet long, which will operate one of 22 elevators placed in the new Hotel Stratford, Philadelphia. Three of these elevators have a run of 289 feet and three a run of 270 feet. These examples of actual installations show what is being accomplished with our plunger elevators for the highest grade passenger service in tall buildings.

The first step in the installation of a plunger elevator is to sink a steel casing, or small caisson into the soil, of slightly larger diameter than the cylinder to provide space for the cylinder itself. The hole is first dug by hand to a depth of about six feet to allow the casing to be set straight; then the drill is put down inside the casing until it comes to the bottom, when the jump-drill machine is started up to operate the drill. Fig. 6 shows one of these machines set up, ready for drilling, which, in this case, is driven by electric motor. At the right of the illustration the drill appears suspended by its rope. When the machine is started it turns the cranks, which throw a lever back on which is a sheave over which the rope passes. The motion of this lever raises the drill a distance of about 26 inches, and when the crank goes over the center the lever is released and the drill drops back and cuts into the ground, and so on, until the drill has worked its way into the ground a distance of about 15 inches below the casing. Then the casing is driven again until it strikes hard bottom, when the drilling is repeated. The hole has to be plumbed about every six feet to make sure of its being straight. In cases where there are ledges we use a rotary machine which works to much better advantage in places like New York City, where it is solid ledge from top to bottom. An annular-shaped drill is used in such cases, which cuts out a solid core of rock. The cutting is done by the pressure of the drill upon steel shot which are dropped into the annular slot that is cut out around the central core.

* * *

The United States consul at Mexico City writes interestingly on rubber culture and its prospects. It appears that large sums of money have been lost by small investors in fake rubber culture schemes, they having been deceived by alluring prospectuses showing the wonderful profits to be gained in a few years. Mr. Conley writes quite discouragingly about the prospects of rubber culture and points out that even if the trees can be made to grow profitably there is ever the prospect of other sources of rubber being discovered, or even that it will be made synthetically from turpentine as camphor is made now. Moreover rubber is not the product of a single species of trees; there are over 1,000 different species of tropical trees from whose sap rubber can be made, and some attempts at cultivation have been made on the unprofitable species. In short, the opportunities for successful rubber culture seem very remote—perhaps the most profitable field is the pockets of the investors.

DETAILS OF THE STANDARD PLUNGER ELEVATOR.

As supplementary to Mr. Waterman's article upon the important new elevator works at Worcester, Mass., the two illustrations, Fig. 1 and 2, herewith, will be of interest, as they show in detail the equipment and principle of operation of the elevators which this firm manufacture. In Fig. 2 is an outline drawing of a "Standard" plunger elevator fitted up complete, with its car, controlling valve, counterweights, etc. When the car is down and the plunger has descended into its cylinder, the plunger is not only supported by the water pressure as supplied to the tube, but also by the pressure due to the displacement of the water by the plunger, or by what may be called the flotation pressure. As the plunger ascends, however, this latter pressure grows gradually less and there is relatively an increasing weight to be taken care of by the counterweight cables, which pass over the pulleys at the top of the elevator shaft. When the car is down these cables add to the weight of the car, and when it is up they add to the weight of the counterweights. This compensating effect of the cables is such as to make the operation of a plunger elevator very successful for high lifts. When the elevator is near the top of its shaft the weight of the cables and counterweights together is sufficient to balance the weight of the car and the upper part of the plunger in addition, which actually places this part of the plunger in tension instead of in compression and removes all liability of the plunger deflecting or buckling under its load, as might be the case on high lifts if the plunger had to support all the load.

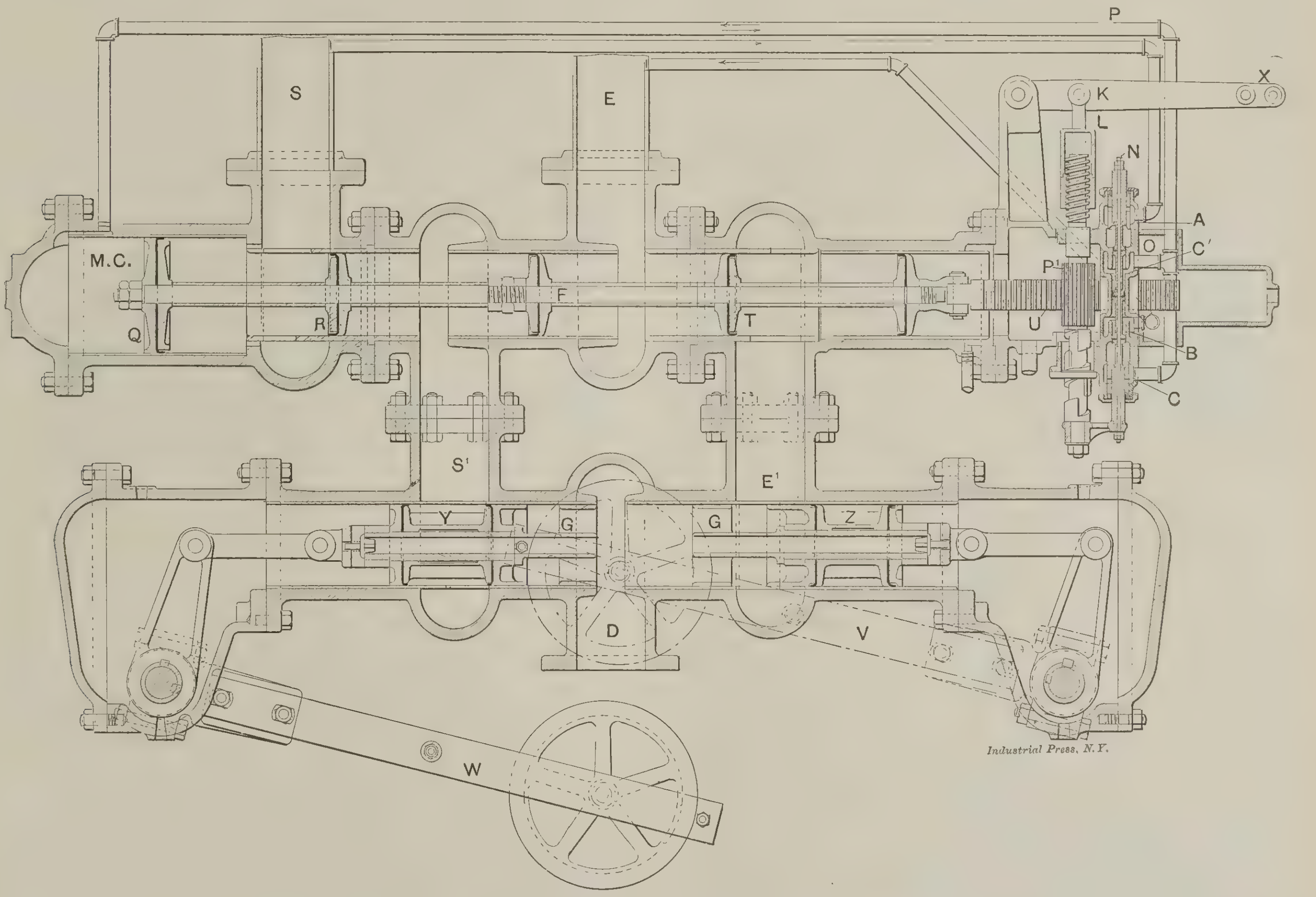


Fig. 1. Controlling Valve of the Standard Plunger Elevator.

The most important part of a plunger elevator, from the operative standpoint, is the controlling valve, and this, as used by the Standard Plunger Elevator Co., is shown in detail in Fig. 1. The inlet or supply pipe is at *S*, the discharge or exhaust pipe at *E*, and at *D* is the connection with the elevator cylinder. The main or operating valve is at *F*, which, in turn, is controlled by the pilot valve at the right of the engraving. The function of the pilot valve is to open or close communication between the left end of the motor cylinder, *M C*, and the supply and discharge pipes, respectively, by means of the small pipe connections at the top of the engraving. The water from the supply pipe is always pressing against the inner faces of pistons *Q* and *R*, which are of different diameters. When water is admitted by the pilot valve to the left of piston *Q* in the motor cylinder, the pressures on each side of this piston will be substantially in balance, and the pressure against *R* will move the main valve *F* to the right. Let the left end of the motor cylinder communicate with the exhaust, however, and the pressure upon *Q* will become unbalanced and the main valve *F* will move to the left.

When the main valve *F* moves to the left, the supply water enters the valve through nozzle *S*, then through nozzle *S'* of the automatic valve, and out through the nozzle *D* to the elevator cylinder, making the elevator car go up. If the main valve is moved to the right, the water in the elevator cylinder will exhaust through nozzles *E'* and *E*, allowing the elevator to come down.

The pilot valve controlling the motion of the main valve is operated from the car by means of a connection with lever *K*, the connection being by a cable at point *X*. If the small valve stem *N* is moved up through lever *K*, links *L* and pinion *P'*, the supply water will enter through the cavity *A* in the pilot valve, and through the small holes in the bushing, pass by the leather-packed piston *O* and through the cavity *C* and pipe *P* into the motor cylinder *M C*. This will cause the main valve to move to the right as before explained. As this valve moves, the pinion *P'* will be revolved by the rack *U* and forced down by means of the nut which is held stationary by the lever *K* and the screw provided at the end of the pinion. This will move stem *N* down so as to shut off communication between the supply and the motor cylinder, thus stopping any further motion of the main stem. If the stem *N* had been moved up a further distance by the operator, the main stem would have traveled a proportionately greater distance before the stem *N* had been moved back sufficiently to close the passage between the supply and the motor cylinder.

If the stem *N* is moved down by the operator, the water is exhausted from the motor cylinder and the main valve *E* moves to the left. This revolves the pinion in the other direc-

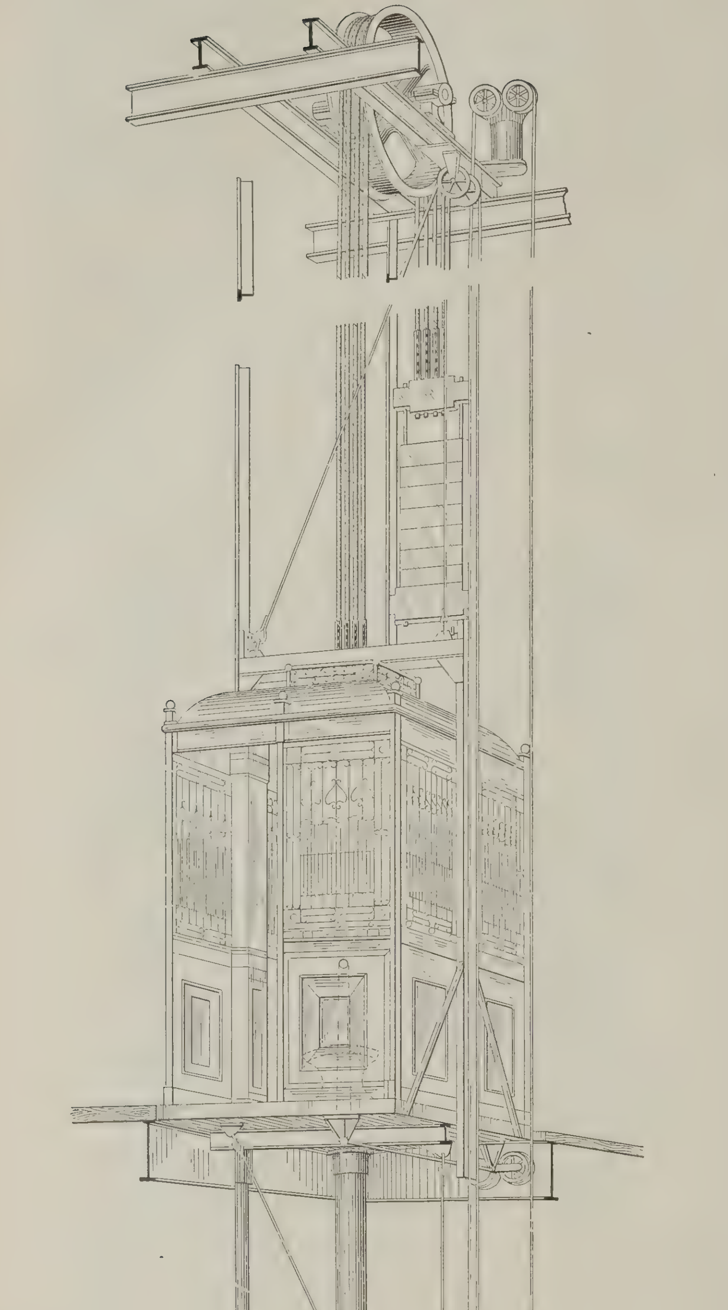


Fig. 2. The Equipment of a Standard Plunger Elevator.

tion, which will then screw itself up on the nut and will move the stem *N* up so as to close the exhaust port from the motor cylinder, thus stopping any further motion of the valve. It will then be seen that the main valve stem will always occupy a position corresponding to the position of the lever *K*, which is controlled by the operator in the car. The catches shown at the lower end of the pinion prevent the lever *K* from being thrown from full open supply to full open exhaust, so as to avoid jumping the elevator off the water when going up or stopping it too suddenly going down.

The action of the automatic stop valve is plainly shown in the engraving. When the elevator approaches the top landing the lever *W* is slowly moved down. This will push the piston *Y* to the right so as to close the passage *S′* and stop the elevator. As the levers *W* and *V* are independent of each other, the closing of the supply opening will not interfere with the exhaust or with the quick starting of the elevator down from the top landing, as the exhaust passage in the automatic valve is fully open until the elevator approaches the bottom landing, in which case the lever *V* will slowly move down and the piston *Z* will close the exhaust opening *E′*.

A weight (not shown) on each lever will automatically open the stop valves as soon as the elevator leaves the top or bottom landing. Should any of the ropes operating the levers *V* and W break, these weights will throw the pistons *Y* and *Z* out to their extreme position so that the sleeves *G* will come opposite the ports and shut down the speed of the elevator. The check valves with small holes through same, shown in the pistons *Y* and *Z*, regulate the speed of the opening of the automatic valves.

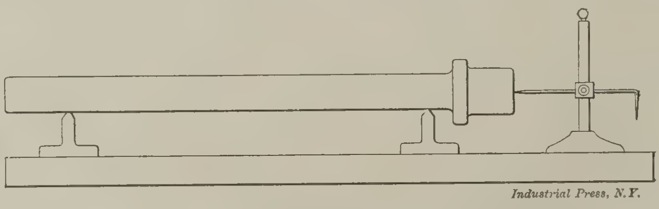
* * *

SPINDLE CONSTRUCTION.—2.

SPINDLE BORING AND FINISHING.

HOWARD P. FAIRFIELD.

Crucible steel forgings for lathe spindles, as delivered to the workman, are usually somewhat crooked and may be enough so as to require straightening, but there is usually an excess of stock to finish, and if the centers are located with judgment the forging will finish out. Various ways of locating the centers are in use in different shops. The cut, Fig. 20, illustrates the method in use in one shop. Two "ways," similar to those used in balancing pulleys, are provided and the forging is laid across these. Care must be exercised to have the "ways" placed so the center of what is to be the journal bearing is central with them. The journals are considered to be the most important parts of the spindle and must clean out when to size. The forging is rolled into several positions on the "ways," and is scribed across each end with a scratch block or a surface gage and the center located with a center punch. The center drilling and reaming is afterward done under a drill press and the forging is ready for the reduction lathe. With the new high-speed steels the forgings are roughed to approximate sizes and shapes at a rapid rate. A feed of 1-16 inch per revolution is a common standard, with a depth of cut of ⅛-inch and a surface speed of one hundred and twenty-five to two hundred feet per minute. While coarser feeds and depths of cut are possible it is not usual to push the tool much beyond those given, on work of this size.



Industrial Press, N.Y.

Fig. 20.

From the reduction lathe, where the roughing is done, the spindle goes to the special spindle drilling lathe illustrated in Figs. 21, 22, and in section in Fig. 27, in which latter cut the drill appears in connection with its extension tube. In Fig. 29, *c*, is shown a drill with straight flutes and in Fig. 28 one with spiral flutes. Either of these drills may be used as tools in the drilling lathe shown.

In Fig. 21, *a* is the tubular extension of the drill *b*. The tool clamp *c*, is held upon an ordinary lathe carriage and is fed to the work in the same manner as a lathe tool in regular turning operations; *d* is a center rest or guide and serves two purposes. It centers the drill and steadies it to its work and it also furnishes a reservoir through which oil is pumped to the drill as it cuts its way through the blank. As shown in Figs. 21 and 23 *d* is drawn back from the drilling position to show the drill more clearly. In use it is close to the end of the spindle or embraces the end as shown in Figs. 22 and 27. The tank *e* is attached to the carriage by a hook and is towed by it. The oil and chips fall into this tank as they are forced through the tube *a* by the pump pressure. The front end of the tank is made of wire netting and this allows the oil to drain to the lathe bed, the chips being held back by the netting. The lathe bed is fitted with a bottom for holding oil and is furnished with a pump to force the oil to the cutting edges of the drill.

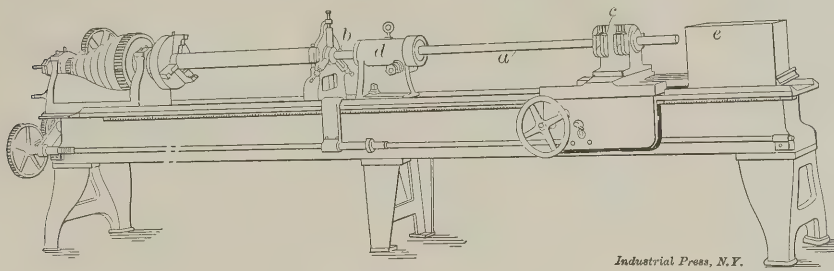


Fig. 21. Spindle Boring Lathe.

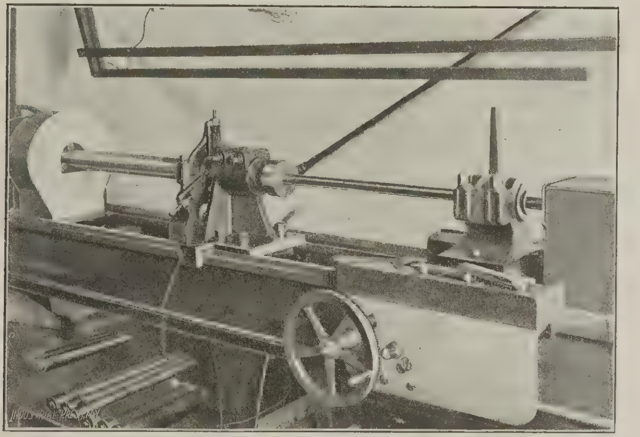


Fig. 22. Drilling the Hole through the Spindle.

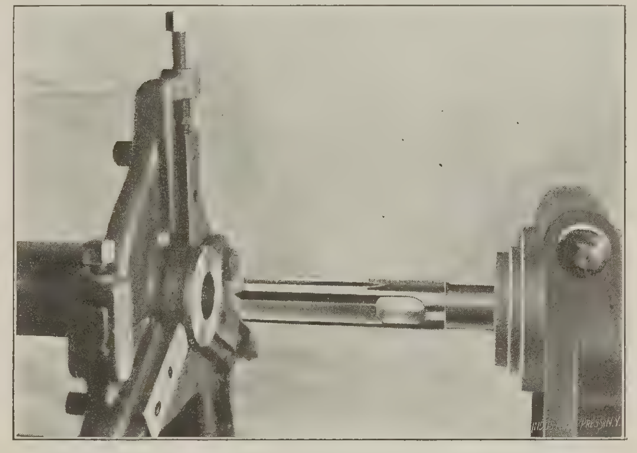


Fig. 23. Showing the Guide drawn back to expose the Drill.

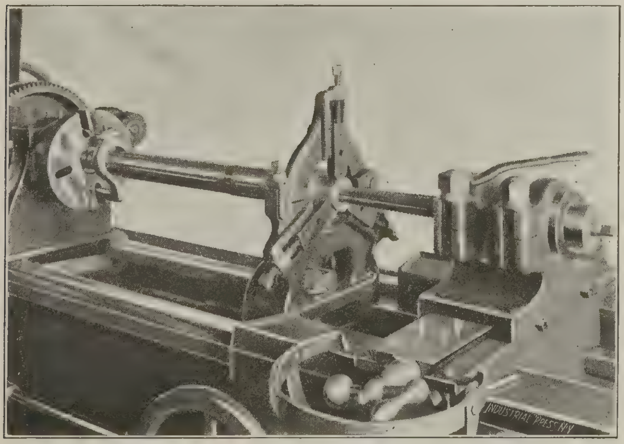


Fig. 24. Roughing out the Tapered Hole.

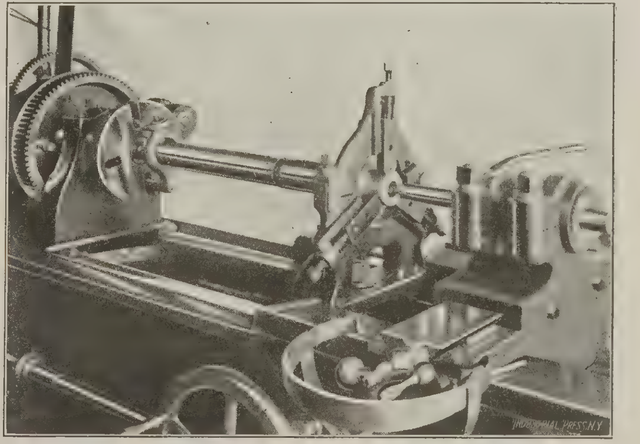


Fig. 25. Truing Hole in End of Spindle with Boring Tool.

By comparing Fig. 28 and Fig. 29, *c*, it will be seen that the oil from the pump strikes the outside of the drill at the rear end of the flutes and is forced along the flat channels on the outer surface until it reaches the cutting end of the drill. The oil then returns by the deep grooves to the hole, where the grooves meet, and thus enters the tube *a*, passing to the tank *e*, taking along at the same time the chips as they are cut from the stock. To ensure a free flow of oil past the cleared end of the drill, the backing at the end of the flute must be ground sharply away, as mentioned in the previous article. Small grooves are ground or milled along the cutting lips to break the chips to a size that can be made to force out with the oil.

While Fig. 21 and Fig. 27 show details of the several parts, Fig. 22 is from a photograph of a spindle drilling lathe in actual use.

When the drilling is completed several methods of finishing the spindle are in vogue, and some of these methods may be of interest. When the hole through the spindle is completed the spindle should be laid aside for a time, that all the strains may relieve. If it is desired that the tapered or center hole be finished before the spindle is ground to dimensions, a hardened and ground plug with a true running center is driven into the rear of the spindle and it is then mounted in a center rest as shown in Fig. 24. The roughing reamer is shown in position to begin roughing the hole to an approximate size and taper. The holder for the roughing reamer is a sleeve with the back end tapped to take an adjustable, threaded center. The shank of the roughing reamer is made to fit loosely in the cylindrical holder and is kept from turning by a pin through the holder and the reamer shank. The rear center hole of the reamer is held upon the threaded center and the reamer is as free to adjust itself as possible, the pin preventing its slipping off the center, and also holding it from turning. The hole is afterward bored to perfect concentricity by using an inside boring tool held as in Fig. 25. To finish the hole a tapered finishing reamer is held rigidly in the tool block and is used to scrape the hole smooth. As little stock as possible is removed by this last operation. The plug in the rear end of the hole is next driven out and the rear end of the spindle is countersunk by using the tool shown at *d*, Fig. 29. This tool is a combined countersink and pilot and is furnished with sleeves that fit nicely into the longitudinal hole.

The test bar shown in Fig. 12 is placed in the tapered hole and the spindle and bar are held on centers in a lathe as in Fig. 26. If now it is found that the test bar shows eccentricity at the front end of the spindle the rear reamed center is scraped until the test bar revolves true when tested with the "indicator." When this is attained it is sure that the center reaming in the rear end is true with the finished tapered hole and when a true running plug is centered in the tapered hole the spindle is in readiness to be threaded, keyseated and ground to fit the several gears, pulleys, bearings, etc., that are in its length. If after these operations are completed the spindle does not test up true, there has been faulty usage in some of the operations. When the face gear, next to the front bearing, is keyed into place it is necessary to countersink it lightly, and then stake down the shoulder on the spindle hard enough to prevent the gear slipping along the spindle when the lathe center is driven out. While staking this gear on, frequent tests should be made to see that the spindle is not thrown out of truth. The method of finishing that follows is another good way of completing the spindle.

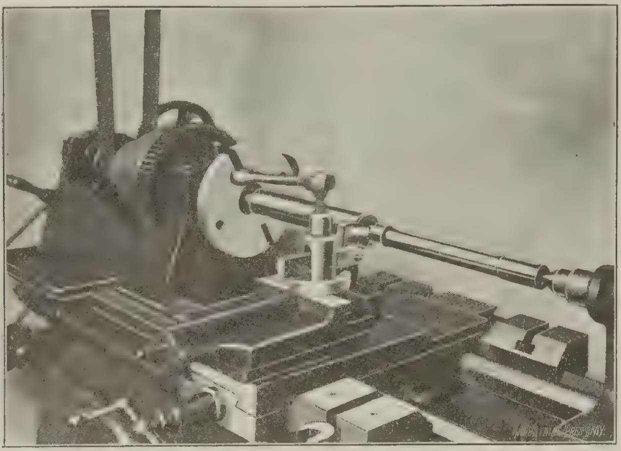
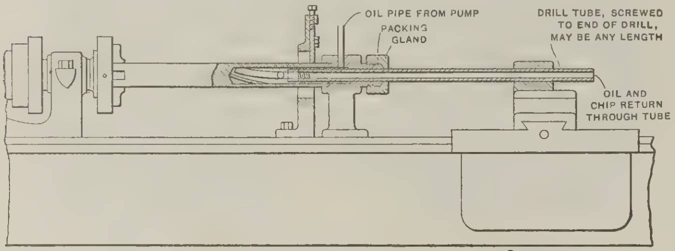


Fig. 26 Accurate Method of Testing Hole in Spindle.


OIL PIPE FROM PUMP
PACKING GLAND
DRILL TUBE, SCREWED TO END OF DRILL, MAY BE ANY LENGTH
OIL AND CHIP RETURN THROUGH TUBE

Industrial Press, Y.N.

Fig. 27. Section of Drill showing means for Oil Circulation.

After the long hole is drilled the edges of the hole at each end are chamfered to a 60 degree bearing using as before the special countersink shown in Fig. 29, *a*, and the spindle is turned to leave .007 of an inch on all diameters for grinding, and all keyways and threads are cut except the thread on the nose of the spindle. An arbor such as the one shown in Fig. 30 is then passed through the spindle and tightened into place by the nut shown. This arbor being a standard upon which many pieces may be ground no pains should be spared to make sure that all surfaces are square and true with a center line. All the grinding is done with the spindle mounted upon this arbor, and as the centers in the arbor are lapped to as near perfection as possible, and are so hard that the wear is small, this method would seem to give very perfectly ground surfaces. The tapered hole is finally finished by holding the spindle upon the live center and in a center rest, as described in the former paper. The truth of the tapered hole can be tested with the "Bath" indicator as in Fig. 10, or the indicator point may be used against the inside of the tapered hole if it is desired. This latter method of testing is shown in Fig. 31, but the one shown in Fig. 10 is to be preferred if the greatest exactness is desired. Figs. 10 and 12 just referred to are to be found in the previous article.

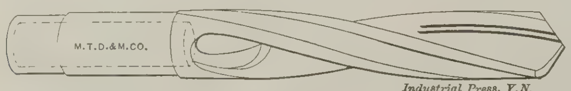


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Fig. 28.

Still another method is to rough-ream the center hole and then grind the several bearings upon plugs driven into the ends of the spindle. When the gears, and the cone pulley are in place the spindle is scraped and fitted into its bearings. After this is done the headstock is mounted on the bed of the machine and the tapered center hole is bored out true, with a tool held in the tool block, and then reamed lightly and tested as before until it is true running within the limit of error set. This method is a good one if the spindle has not been changed after it was ground. It is quite likely, however, that some changes have taken place when the gears were keyed on, and the spindle is out of true. If the center hole is then bored with the spindle in its bearings the center hole is true with an imperfect and twisted spindle. Using the lathe tends to relieve the strains put into the spindle by keying and staking on the gears and it assumes its original truth as ground. This throws the tapered center hole out of line with the lathe and results in a poor running live center and one that can only by accident be replaced and run true. By the first two methods, of finishing the center hole and the surface of the spindle true with each other, any changes made when setting up can be detected and remedied at the time of their occurrence.

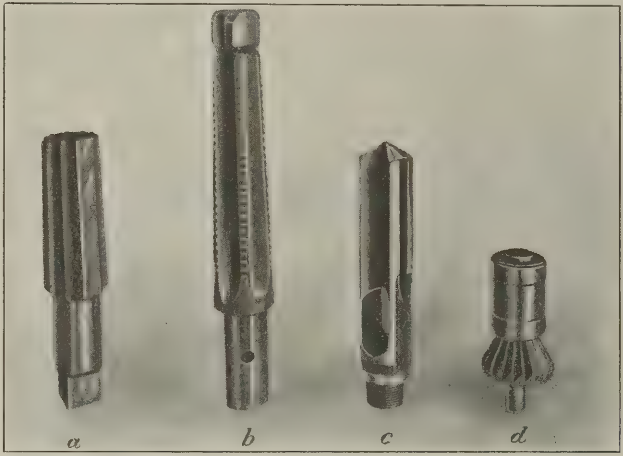
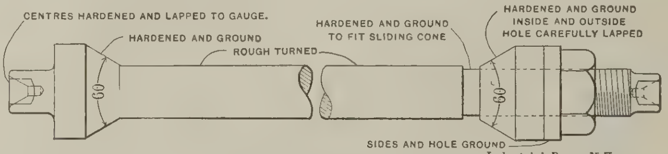


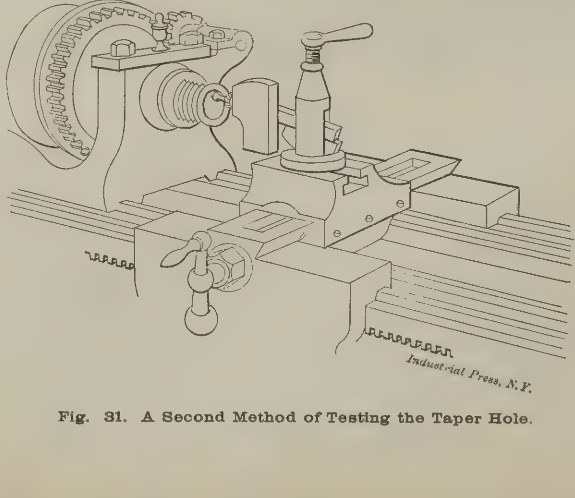
Fig 29. Tools used in Machining the Spindle Hole.


CENTRES HARDENED AND LAPPED TO GAUGE.
HARDENED AND GROUND
ROUGH TURNED
HARDENED AND GROUND TO FIT SLIDING CONE
HARDENED AND GROUND INSIDE AND OUTSIDE HOLE CAREFULLY LAPPED
60°
60°
SIDES AND HOLE GROUND

Industrial Press, N.Y.

Fig. 30.

The spindles made by the above described methods are usually of sixty point carbon and are unhardened. If greater wearing qualities are desired in the spindle bearings than such spindles will give, low carbon steel is often used for the spindle, and the bearings are then casehardened. The casehardening is done just before the grinding and fitting and is from 1-32-inch to 1-16-inch deep, and only on the surfaces used for the bearings. To accomplish this, the parts



Industrial Press, N.Y.

Fig. 31. A Second Method of Testing the Taper Hole.

it is desired to retain soft are copper-plated before treating the surfaces it is desired to harden. This copper-plating prevents the action of the case-hardening compound upon these surfaces and the unplated surfaces only are hardened.

In grinding spindles with a long keyway in the surface, as for instance a drill press spindle, it is usual to fit a strip of hard wood into the keyway, and then shape the wood to the circumference of spindle. When grinding spindles it is desirable to have two grinding machines so set as to have the workman between the two. One machine will have a coarser wheel mounted and will bring the spindles to within .001 of an inch of size; they can then be finished upon the second machine with a finer wheel, leaving a surface that does not need polishing. A feed of from one-quarter to three-eighths inch per revolution should be maintained when grinding, and the spindle should be amply supported by back rests.

* * *

PLANER FOR HIGH-SPEED STEELS WITH QUICK RETURN OF 200 FEET PER MINUTE.

Before the introduction of high-speed steels it was considered good practice to operate a planer at a cutting speed of 20 feet per minute, returning the platen in the ratio of about 4 to 1, or at a speed of about 80 feet per minute. In adapting planers to use high-speed steels, however, the cutting speed has had to be increased, but it has not been possible to maintain the ratio of the return to the cutting speed at 4 to 1, because of the enormous inertia to be overcome at high speeds when the motion of the platen is reversed. This inertia is proportional to the squares of the speeds of the moving parts and is influenced mainly by the high return speed of the platen and the high speeds of the belt pulleys, which must be reversed at each stroke of the planer.

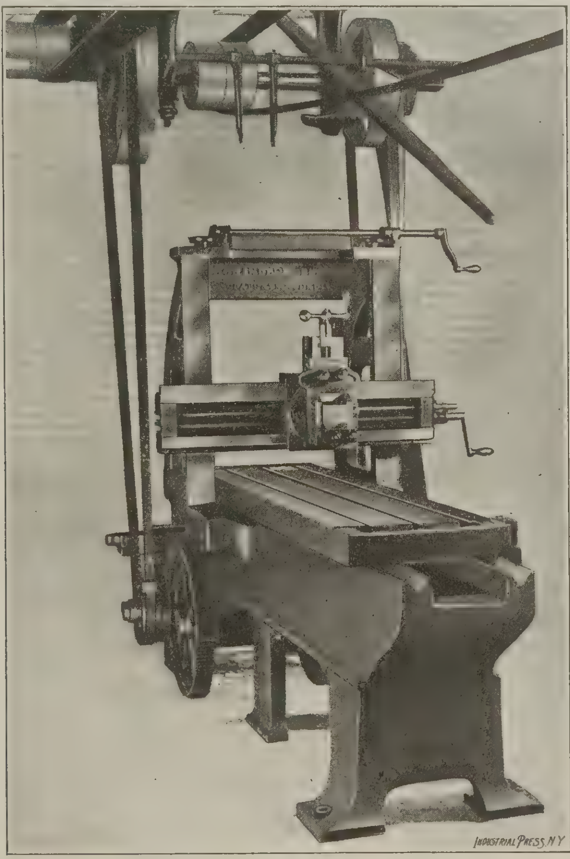


Fig. 1. The Chandler Planer, which runs at a Cutting Speed of 60 feet per minute, returning at 200 feet per minute.

If the planer were cutting at the rate of 20 feet per minute and returning at 80 feet, the inertias of the platen during the cutting and return strokes would be in the ratio of 400 to 6,400. But if the cutting speed were increased to only 25 feet per minute, and the return were maintained at 4 to 1, the inertia during the return would be represented by the large increase of from 6,400 to 10,000. Hence it is that while the cutting speeds of planers have been somewhat increased to adapt them to high-speed steels, it has been necessary to keep the return speed at somewhere near the constant figure of 80 feet per minute.

In view of these facts a planer now in operation in the shops of the Chandler Co., Ayer, Mass., is of unusual interest because it not only runs at a cutting speed high enough to severely tax a Novo steel tool, but maintains its ratio of 4 to 1 for the return speed, without any difficulty whatever. The machine is the invention of Mr. D. L. Chandler, of the Chandler Co., and has been in operation several months, during which time it has been subjected to all kinds of rough usage and hard work, with a view to discovering its weak points, should any develop, before placing the planer on the market.

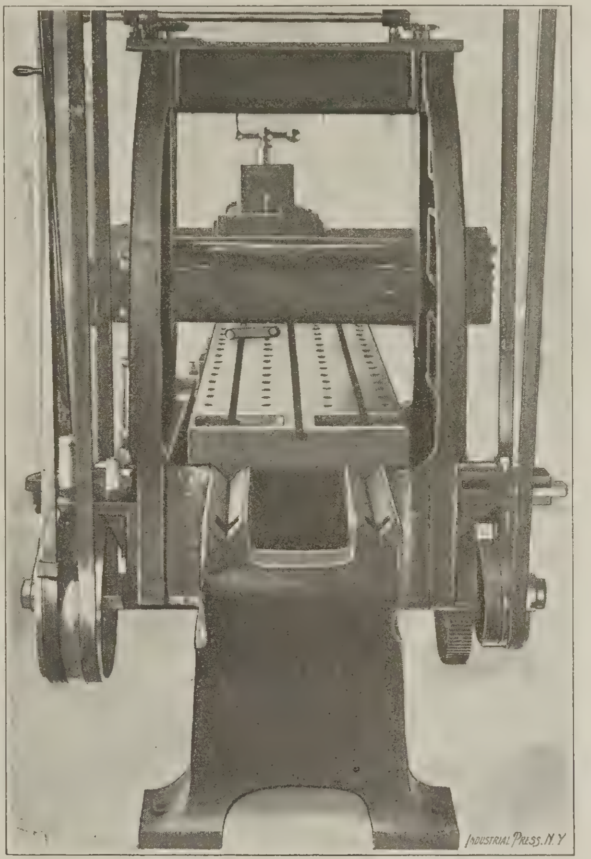


Fig. 2. Rear View showing the three Driving Belts. The one at the extreme left is for the Cutting Speed; the next is for reversing the Platen and the one at the right for the quick return of Platen.

The planer was designed to operate at a cutting speed of 50 feet per minute and to return, as stated, in the ratio of 4 to 1, or at speed of 200 feet per minute; but we are informed that it had been speeded to cut at nearly or quite 60 feet per minute, returning at 200 feet. At these high speeds the platen runs so smoothly that a 6-inch bolt rides upon the platen on a 1⅜-inch head with less disturbance to its equilibrium than is created in slow-running planers with the ordinary style of drive.

The planer is a 24 x 24-inch machine driven by 1½-inch double belts. The writer had an opportunity to time it under actual test, while taking a cut over the surface of a bar of machinery steel 4 feet 4 inches long and 4 inches wide. A tool of Novo steel was used and the cut taken was approximately 5-32-inch deep, with 5-32-inch feed. The time consumed was 3 minutes and 50 seconds, and at the conclusion the tool was somewhat the worse for wear. Under so heavy a cut the speed of the planer was probably somewhat below normal, owing to the slipping of belts. Another job—surfacing cast iron—consisted in roughing out a table 16 inches wide by 5 feet 4 inches long in 11½ minutes and finishing the same with a second cut, taking a broad chip, in 6 minutes.

This important advance in planer speeds is secured by mechanical means that are extremely simple and apparently lead to no complications likely to call for frequent repairs. In fact, we believe that because of the easy reversal of the platen the repair charges will be considerably reduced rather than otherwise.

The principle of the planer is the employment of three belts, one for driving, when cutting, one for reversing, and one for running the platen back at high speed. As the platen approaches the end of the cutting stroke, the tappet encounters an incline on the dog and is lifted to a position which throws off the cutting belt and throws on the reversing belt, running at a speed that will most effectively reverse the cutting movement of the platen. Thus far, except in details of construction, there is nothing new. The two belts are shifted practically as they are in planers of other makes.

As soon as the platen starts back on its return stroke, however, the tappet encounters a second incline on the dog and is further elevated, throwing off the reversing belt and throwing on the high-speed return belt, which remains in action until near the end of the return stroke, when the tappet encounters a two-step dog, which, on the first step, throws off the high-speed return belt and throws on the slow return or reversing belt. The second step of the dog then throws off the reversing belt and throws on the cutting-speed belt.

The cutting-speed and reverse belts are on the front side of the planer, as in the ordinary type, and the high-speed return belt is on the opposite or rear side of the machine. The arrangement of the belts, pulleys and cams is clearly shown in the line engraving in Fig. 3. At the left of the engraving are two loose pulleys and one tight pulley and on the same shaft at the right are the tight and loose pulleys for the high-speed belt. The two belt shifters at the left are controlled by an oscillating cam having two slots for the rolls, *A*, *B*, attached to the short arms of the shifters. This cam is connected with the sliding cam at the right by the rod *R* so that the two move in unison.

Starting with cam *D*, and with the cutting-speed belt on the tight pulley, as shown, movement of cam to the left causes roll *A* to ride up on surface *a*, *a'*, shifting belt to loose pulley, where it remains until the cam again returns to this point. In the meantime roll *B* travels on surface *b*, *b'*, causing the reversing belt to shift to the tight pulley, where it remains momentarily, and then shifts back to the loose pulley again as the roll passes over the cam surface from *b'* to *b''*. While this belt is being shifted back to the loose pulley, however, the curved part of cam *E* comes into action and shifts the high-speed belt onto its tight pulley, the roll *C* being in contact with cam surface *c*, *c'* during this motion. When the platen finally reaches the other end of its stroke these successive motions occur in the reverse order and the platen is finally carried back to its original position by the slower cutting-speed belt. The speeds, as laid out for the first planer, were 50 feet cutting speed (afterward changed to about 60 feet); 74 feet reversal speed and 200 feet return. For short-stroke work, or any work requiring a particularly accurate stop, the quick-return belt may be thrown out of action entirely by simply raising a latch on the forward planer dog *E*, Fig. 4. The planer then immediately becomes a two-belt planer, with a cutting speed of 50 feet and return of 74 feet per minute.

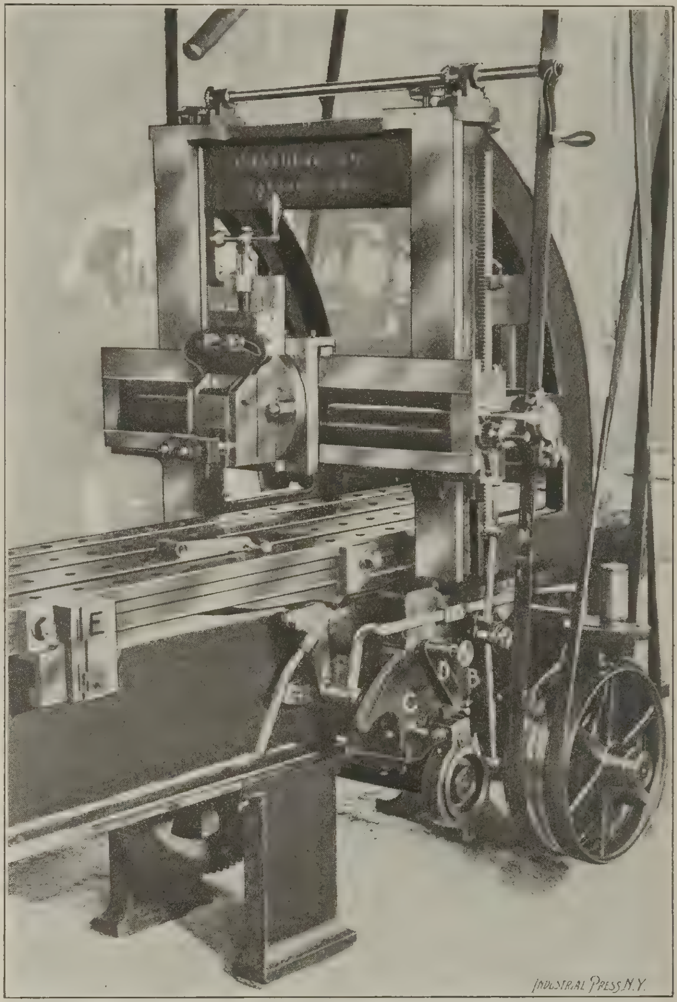


Fig. 4. Side View, showing Details of Variable Feed Mechanism.

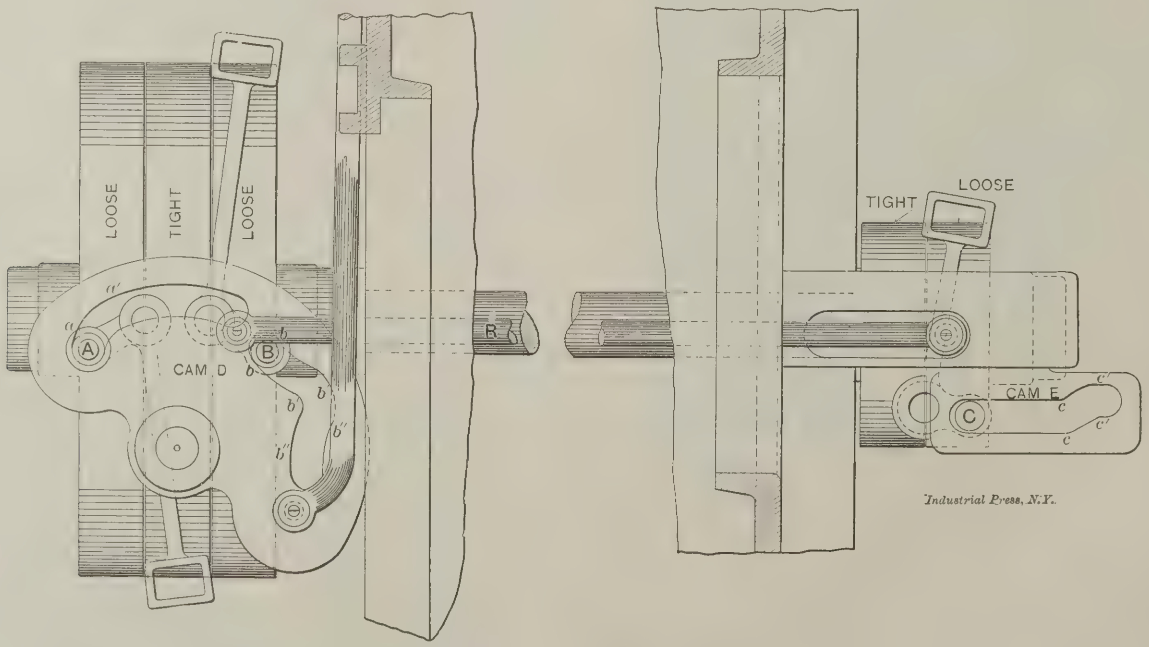


Fig. 3. Details of Belt-shifting Mechanism.

It is apparently the case that the Chandler Co. are getting remarkably good results with their planer when running it with two belts only, and they attribute this largely to the use of hardened and ground shafting for the entire driving mechanism. One of the chief difficulties with a planer when pushed to its limit is the cutting of the journals and bearings, owing in part to the high speed of the first or pulley shaft and in part to the severe stresses that the journals must sustain when the tool is cutting or the platen is being reversed. Mr. Chandler has given much attention to the hardening of large pieces of work and he finds that with hardened and ground shafting running in cast iron bearings, he can maintain smooth journals and bearings indefinitely, under the most severe conditions. This is a feature in machine construction well worth noting, as it not only contributes to continuous running without repairs, but to a small friction loss as well.

Several other features have been introduced, one of which is the feed regulating device. Instead of regulating the amount of feed by moving a wristpin to or from the center of the friction box, the movement of the friction box itself is controlled by a lever, as shown in Fig. 4. A movement of the friction box in one direction is stopped by a stationary pin *C*; but its movement in the other direction is controlled by a pin *B* attached to the lever *D*. The position of this lever is indicated by a marked dial, and it is easily changed to any position, whether the planer is running or stationary, thus placing the feed under the immediate control of the operator, and enabling him to select that which is best adapted to his work.

Another improvement is the arrangement of the feed on the cross rail. This consists of a simple ratchet arrangement by which the pawl is prevented from engaging the ratchet teeth except at the very instant of feeding. The feed handle may therefore be turned freely in either direction, and the tool backed out of the work without the necessity of changing any part of the feed mechanism.

A second planer is now partly completed which will embody some of the improvements suggested by the firm's experience with the first machine. Among these improvements is a speed-changing device for altering the speed of the platen without changing the speed of the driving belts. The full power of the belts, therefore, will be preserved for use at all times, as is not the case where the speed-varying mechanism is in the countershaft.

* * *

EARLY STEAM ENGINES.—2.

In a contribution appended to the article "Steam Engine" in Robinson's "System of Mechanical Philosophy" (1822), James Watt, the father of the steam engine, gave an account of the experiments and reflections which led up to his first invention. This narrative has been republished in Ewing's text book on the steam engine, from which the following abstract is taken, and it will afford an interesting addition to the article upon Early Steam Engines contributed by Mr. A. R. Bell in the last number:

"My attention was first directed, in the year 1759, to the subject of steam engines, by the late Dr. Robinson, then a student in the University of Glasgow, and nearly of my own age. He at that time threw out an idea of applying the power of the steam engine to the moving of wheel-carriages, and to other purposes, but the scheme was not matured.

"About 1761 I tried some experiments on the force of steam, in a Papin's digester, and formed a species of steam engine by fixing upon it a syringe one-third of an inch diameter, with a solid piston, and furnished also with a cock to admit the steam from the digester, or shut it off at pleasure, as well as to open a communication from the inside of the syringe to the open air, by which the steam contained in the syringe might escape. When the communication between the digester and the syringe was opened, the steam entered the syringe, and by its action upon the piston raised a considerable weight (15 pounds), with which it was loaded.

"When this was raised as high as thought proper, the communication with the digester was shut, and that with the atmosphere opened; the steam then made its escape, and the weight descended. The operations were repeated, and though in this experiment the cock was turned by hand, it was easy to see how it could be done by the machine itself, and to make it work with perfect regularity. But I soon relinquished the idea of constructing an engine upon this principle, from being sensible it would be liable to some of the objections against Savery's engine, viz., the danger of bursting the boiler, and the difficulty of making the joints tight, and also that a great part of the steam would be lost, because no vacuum was formed to assist the descent of the piston.

"The attention necessary to the avocations of business prevented me from then prosecuting the subject further; but in the winter of 1763-64, having occasion to repair a model of Newcomen's engine belonging to the Natural Philosophy class of the University of Glasgow, my mind was again directed to it. At that period, my knowledge was derived from Desaguliers, and partly from Belidor. I set about repairing it as a mere mechanician, and when that was done and it was set to work, I was surprised to find that its boiler could not supply it with steam, though apparently quite large enough (the cylinder of the model being two inches in diameter, and six inches stroke, and the boiler about nine inches diameter). By blowing the fire, it was made to take a few strokes, but required an enormous quantity of injection water, though it was very lightly loaded by a column of water in the pump. It soon occurred that this was caused by the little cylinder exposing a greater surface to condense the steam than the cylinders of larger engines did in proportion to their respective contents. It was found that by shortening the column of water in the pump, the boiler could supply the cylinder with steam, and that the engine would work regularly with a moderate quantity of injection. It now appeared that the cylinder of the model being of brass, would conduct heat much better than the cast-iron cylinders of larger engines (generally covered on the inside with a stone crust) and that considerable advantage could be gained by making the cylinders of some substance that would receive and give out heat slowly; of these, wood seemed to be the most likely, provided it should prove sufficiently durable.

"A small engine was therefore constructed with a cylinder six inches diameter, and twelve inches stroke, made of wood, soaked in linseed oil, and baked to dryness. With this engine many experiments were made; but it was soon found that the wooden cylinder was not likely to prove durable, and that the steam condensed in filling it still exceeded the proportion of that required for large engines according to Desaguliers.

"A boiler was constructed which showed, by inspection, the quantity of water evaporated in any given time, and thereby ascertained the quantity of steam used in every stroke by the engine, which I found to be several times the full of the cylinder. Astonished at the quantity of water required for the injection, and the great heat it had acquired from the small quantity of water in the form of steam which had been used in filling the cylinder, and thinking that I had made some mistake, the following experiment was tried: A glass tube was bent at right angles, one end was inserted horizontally into the spout of a tea-kettle, and the other part was immersed perpendicularly in well-water contained in a cylindric glass vessel, and steam was made to pass through it until it ceased to be condensed, and the water in the glass vessel was become nearly boiling hot. The water in the glass vessel was then found to have gained an addition of about one-sixth part from the condensed steam. Consequently, water converted into steam can heat about six times its own weight of well-water to 212 degrees, or till it can condense no more steam. Being struck with this remarkable fact, and not understanding the reason of it, I mentioned it to my friend, Dr. Black, who then explained to me his doctrine of latent heat, which he had taught for some time before this period (summer 1764), but having myself been occupied with the pursuits of business, if I had heard it I had not attended to it, when I thus stumbled upon one of the material facts by which that beautiful theory is supported.

"On reflecting further, I perceived that in order to make the best use of the steam, it was necessary that the cylinder should be maintained always as hot as the steam which entered it; and secondly, that when the steam was condensed, the water of which it was composed, and the injection itself should be cooled down to 100 degrees, or lower, where that was possible. The means of accomplishing these points did not immediately present themselves; but early in 1765 it occurred to me that if a communication were opened between a cylinder containing steam, and another vessel which was exhausted of air and other fluids, the steam, as an elastic fluid, would immediately rush into the empty vessel, and continue so to do until it had established an equilibrium, and that if that vessel were kept very cool by an injection or otherwise, more steam would continue to enter until the whole was condensed. But both vessels being exhausted, or nearly so, how were the injection water, the air which would enter it, and the condensed steam, to be got out?

"This I proposed, in my own mind, to perform in two ways. One was by adapting to the second vessel a pipe reaching downward more than 34 feet, by which the water would descend (a column of that length overbalancing the atmosphere) and by extracting the air by means of a pump.

"The second method was the one I then preferred, and is the only one I afterward continued to use. In Newcomen's engine, the piston is kept tight by water, which could not be applicable in this new method; as, if any of it entered into a partially exhausted and hot cylinder, it would boil and prevent the production of a vacuum, and would also cool the cylinder, by its evaporation during the descent of the piston.

"I proposed to remedy this defect by employing wax, tallow, or other grease, to lubricate and keep the piston tight. It next occurred to me that the mouth of the piston being open, the air which entered to act on the piston would cool the cylinder, and condense some steam on again filling it. I therefore proposed to put an air-tight cover upon the cylinder, with a hole and stuffing-box for the piston-rod to slide through and to admit steam above the piston to act upon it instead of the atmosphere. (N. B. The piston-rod sliding through a stuffing-box was new in steam engines; it was not necessary in Newcomen's engine, as the mouth of the cylinder was open, and the piston stem was square and very clumsy. The fitting of the piston rod to the piston by a cone was an after improvement of mine, about 1774.) There still remained another source of the destruction of steam—the cooling of the cylinder by the external air, which would produce an internal condensation whenever steam entered it, and which would be repeated every stroke. This I proposed to remedy by an external cylinder containing steam, surrounded by another of wood, or of some other substance which would conduct heat slowly.

"When once the idea of the separate condensation was started, all these improvements followed as corollaries in quick succession, so that in the course of one or two days the invention was thus far complete in my mind, and I immediately set about to verify it practically.

"A large model with an outer cylinder and wooden case was immediately constructed, and the experiments made with it to verify the expectations I had formed, and to place the advantage of the invention beyond the reach of doubt. It was found convenient afterward to change the pipe-condenser for an empty vessel, generally of a cylindrical form, into which an injection played, and, in consequence of there being more water and air to extract, to enlarge the air pump.

"The change was made, because, in order to procure a surface sufficiently extensive to condense the steam of a large engine, the pipe-condenser would require to be very voluminous, and because the bad water with which engines are frequently supplied would crust over the thin plates, and prevent their conveying the heat sufficiently quick. The cylinders were also placed with their mouths upward, and furnished with a working-beam and other apparatus as was usual in the ancient engines; the inversion of the cylinder, or rather of the piston-rod in the model, being only an experiment to try more easily the new invention, and being subject to many objections in large engines."

* * *

The Publication Department of the B. F. Sturtevant Co. is to receive generous recognition in the allotment of space in the new office building at Hyde Park. A portion of the high basement, about 40 feet square, will be devoted to a press room and storage space for paper stock and printed matter. A full equipment of type and of jobbing and catalogue presses will be installed. Immediately above this room and occupying one end of the first story of the same building, will be the offices with a full complement of artists, clerks, etc. The Sturtevant Co. has for several years maintained a printing plant of its own, and is to-day carrying through all the work required in connection with its publications, except the engraving.

THE USE OF MAGNETS IN CONNECTION WITH CRANES.

DR. ALFRED GRADENWITZ.

Magnets have been used for a long time in connection with cranes and hoisting devices, but the danger arising from a careless handling of the goods has been a material drawback to the adoption of similar cranes. On the other hand, certain bodies, such as, for instance, tubes, figured iron, rails, etc., being conveyed by means of an ordinary hoisting device from one place to another cannot always be caught by the tongs fitted to the hoist with the safety required on account of their shape or the way they are stood up. In the case, however, of a magnet being used alone, there is the risk of the current being interrupted from some cause, during the lifting and conveying of the goods, and the men in charge of the crane being seriously injured by the goods falling down.

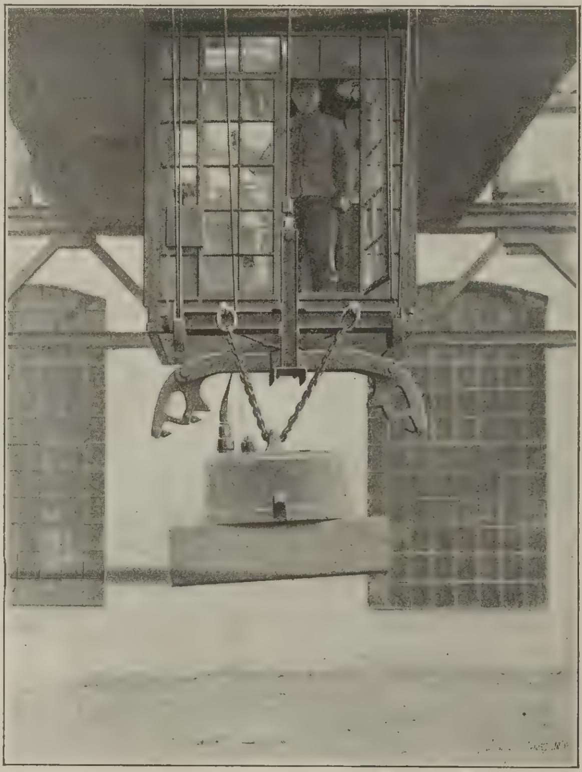


Fig. 1. Lifting Magnet with Tongs for Holding Work when the Current is off.

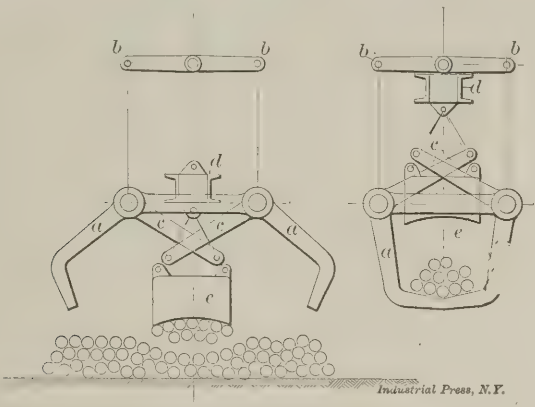
The ingenious device described in this article has been patented both in Germany, United States and England by the crane-building firm of Ludwig Stuckenholtz, Wetter a/Ruhr. Such magnets as are to be used, for instance, in transporting rails, tubes, etc., are combined with two pairs of grips or bows, closing beneath the magnet. The working of the apparatus is as follows:

The magnets, being as a rule traversed by no current, i. e., non-magnetic, are dropped on the objects to be transported and next magnetized by switching in the electric current. Simultaneously with the magnet or magnets being lowered, the above bows or grips will open automatically. After the magnet has lifted the body in question, the bows close automatically, when the magnet on the current being switched off will be able to transmit the lifted goods to the bows, this ensuring on one hand a saving of current and on the other hand enabling a transport to be made even above the heads of men working underneath, without any danger to the latter.

The design of the apparatus is shown in the accompanying sketch, where the catching tongs *a* are suspended from the transversal piece *b*, the inward-directed arms *c* crossing one another and being so connected to the vertically movable longitudinal girder *d* (to which the magnet *e* is connected), that the tongs are opened on the girder *d* being lowered along with the magnet, to be closed again as soon as the above parts have been lifted up to a certain height. In Fig. 2 the longitudinal girder *d* is supposed to be dropped, the jaws of the tongs *a* being opened and the magnet having penetrated between them and attracted a number of tubes. In order to facilitate as far as possible the attraction of the magnet and to maintain it in position, the lower surface of the magnet should have an inward curvature.

Now on the magnet *e* rising again, the tong *a* will close, and on the current being interrupted, the magnet drops the tubes into the closed tongs, when they may be conveyed to the desired place by means of a crane or any other hoisting device, being safe in the hollow of the tongs.

The shape of the tongs may be varied at will according to the kind of goods to be transported. In a special type, the tongs are replaced by a single movable bow whence the goods may slide down easily. This type allows also of the less heavy objects being placed in the bow by hand, after the heavy goods have been lifted by the magnet.



Details of Tongs.

This exceedingly suitable device allows not only of transporting without any danger any large and massive objects, but also of handling rapidly and safely such goods as ores, scrap iron, pig-iron, as well as any description of small iron, by combining the magnet to vessels opening underneath.

When considering that all the movements, in fact the whole of the loading, are readily controlled and effected by a single man in a minimum of time, it will be seen that this invention opens up for the magnet a nearly unlimited field in connection with the transportation of goods.

As shown by the crane represented in Fig. 1, the inventor has found also other means of combining the magnets with tongs, etc. The crane serves to transport hot and cold ingots. Now as the magnet cannot be used to lift blocks of a temperature higher than 750 deg. C., the catching tongs are made to replace the magnet with these temperatures, the exchange being made most rapidly.

* * *

A DRAGGING DIE DOES NOT STRETCH THE THREAD.

Editor MACHINERY:

In his April article upon tool making Mr. Markham says that a screw may be stretched in cutting by allowing the die to drag the slide along.

When I read that it seemed unreasonable to me, and to test the statement I threaded some studs which are sent you herewith. The studs were all threaded with a die at one cut, in a lathe of about 16 inches swing, from 5-16 rod held in the chuck.

While threading No. 1 the die was allowed to advance at the normal rate without help or hindrance. While threading No. 2 the carriage was drawn along by the die, but while threading No. 3 the die was urged ahead by drawing the tailstock tight against it by means of the carriage.

It is quite easily seen that the lead of No. 2, on which the die was situated, is less than that of No. 1, rather than more, and also that the lead of No. 3 is greater than that of No. 1. It should have been stated that the carriage used moved as easily as the average 16-inch lathe carriage. Notice that increased lead was caused by pushing the die ahead rather than by holding it back.

While this same conclusion can be easily reached by simple reasoning, practice affords the final test after all, so I do not see how the case could be strengthened by argument. I'd like to ask how long a cylinder head would stay tight, if the material commonly used in studs could so easily be given a permanent set?

Grand Rapids, Mich. G. M. JOHNSTON.

[We attempted to make an engraving from the threaded pieces sent us by Mr. Johnston, which would show the differences in pitch; but these differences, though of mechanical importance, are so slight from the standpoint of the engraver's art that it is difficult to indicate them in a half-tone illustration. By measuring the pitches of the different screws, we find that No. 1 has 97 threads in a length of 5½ inches; No. 2, 97½; and No. 3, 99 threads. In a 5-16-inch screw, 18 threads to the inch, there should be 99 threads in a length of 5½ inches. —EDITOR.]

* * *

BRINGING THE TOOLS TO THE WORK.

The accompanying illustration, from a photograph sent us by Mr. Frank C. Perkins, shows two pneumatic tools and a portable slotter at work on a rotating field ring at the shops of the Elektricitats-Actien Gesellschaft, formerly Schuckert & Co., Nurnberg, Germany. The floor-plate system, whereby heavy castings are leveled and clamped to massive cast iron floor plates and then machined by electrically-driven portable machine tools, pneumatic tools, etc., has come into use the world over, and this illustration, besides being of interest because from a German shop, affords an instructive example of the advantages of taking the tool to the work. There are in all five men performing some operation on the casting—one running the slotter, two using pneumatic tools, besides two who are chipping by hand. The slotter is designed for an unusually long stroke and is essentially a vertical planer. The ram is driven by a train of gears, but the reversal of stroke is obtained through friction clutches instead of by a shifting belt. The clutches are operated by a sliding cam on the front of the head of the machine. The cam receives its motion from a tappet on the ram, which strikes a collar clamped to a vertical rod attached to the cam, at each extreme of the ram's travel. The cam slides between two rollers on a horizontal sliding bar, which in turn operates the clutches.

German Portable Slotter.

* * *

A correspondent of the *Scientific American* says that glass can be turned in the lathe and that it can be done better with steel tools than with the diamond. The diamond scrapes and works more slowly, while steel tools can be forced and can be worked at sharper angles, say, 50 or 60 degrees. Moreover, it appears that turning can be successfully done in hand lathes with the tool held over a rest, as in wood turning. The speed should not exceed 15 feet per minute, and slower speed is better. The most effective lubricant is water applied in a continuous stream at the point of the tool. The turning of glass, of course, has its largest field of application in optics, in the making of experimental lenses and similar work.

TOOL MAKING.—8.

SCREW THREADING DIES (Concluded).

E. R. MARKHAM.

Round Dies.—While round dies are oftentimes made solid when they are to be used in roughing a thread preparatory to finishing with another die, a die for cutting screws to a gage or an exact size must be of a form known as an adjustable die, i. e., that may be adjusted to compensate for wear or any desired change of size. The means of adjustment is furnished by splitting the die, as shown in Fig. 22, leaving a thin partition of stock at the outside, as shown in Fig. 23, to prevent the die from springing when hardened. When making this cut commence at the center and cut toward the surface.

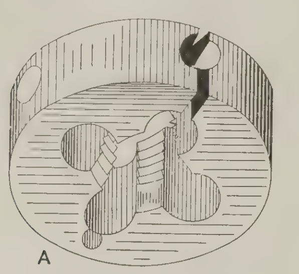


Fig. 22

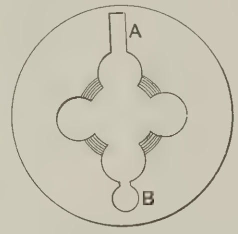


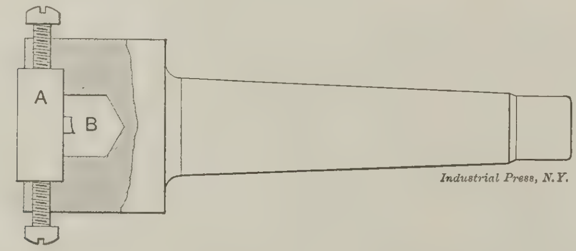
Fig. 23

Industrial Press, N.Y.

Solid dies must be tapped with a tap of the exact size of the screw to be cut, there being no means of adjustment, but the finish tap—or hob—used in tapping adjustable dies is made a trifle large, as when the die is closed to the proper size a slight clearance is given to the heel of the land, which causes the die to cut easier than it would otherwise. The same general remarks in the June issue relative to square dies apply to the round.

After finishing the die and before hardening, run the finish-hob through to remove any burrs and dirt that may be in the thread.

If many round dies are to be made, all of the same outside diameter, it is advisable to use a holder to receive the dies while they are being faced to thickness and drilled and tapped. This holder may be made to screw on the end of the live spindle of the lathe, after the fashion of a chuck, or face-plate, or it may have a tapered end to fit the tapered hole in the spindle, as in Fig. 24, the opposite end being bored out to receive the die, as shown. Screws are used to hold the die in place while it is being machined. An opening somewhat smaller than the one receiving the die is provided, as shown at *B*, Fig. 24, which allows the drills, reamer and tap to pass through the work without striking the holder. Holes may be drilled through the holder to allow the chips to fall out; but few chips are made when drilling one die, and the holder can be cleaned after each die is removed, so it does not appear necessary to provide these holes, and besides, the holder revolving would throw chips and oil through the holes, and make them a nuisance rather than a help.



Industrial Press, N.Y.

Fig. 24.

The die blank is turned and finished to diametral measurements, and cut a trifle thick. It is then placed in the holder, and one side is faced true and smooth; after which it is removed and reversed in the holder and the opposite side faced to thickness. It is now ready to be drilled and tapped. The other operations are essentially the same as those already described, unless the die is to be made adjustable, in which case the small hole shown at *A*, Fig. 22, is drilled so as to break into the clearance hole.

The splitting of the die, to make it adjustable, should be done with a saw or with a narrow file which is cut on the edge. The splitting should not be carried quite to the outside, but should be left as shown in Fig. 23, to prevent the die springing when it is hardened.

Pack-hardening provides an excellent means of hardening dies for cutting threads, but if this method cannot be used they should be very carefully heated in a tube, or some receptacle, where they are protected from the fire. Extreme care should be exercised in heating; the heats should be uniform and no higher than is necessary. Then the die should be grasped with a pair of tongs, Fig. 25, immersed in a bath of lukewarm water or brine, and swung back and forth in the bath in order that the contents may readily pass through the die opening, as this is the portion desired hard.

A very excellent method is to have a holder or a pair of tongs that will take the die as indicated in Fig. 26. In this way the outer rim is protected from the action of the water which, however, has free access to the portion desired hard. The temper should be drawn to a full straw, while the portion between the small hole (*A*, Fig. 22) and the outer edge of die should be drawn to a blue color so that it may spring without breaking when the die is adjusted to cut to size.

After the temper is drawn the thin partition (Fig. 23) may be removed by grinding with a thin emery wheel or a bevel wheel. If it is desirable to have a V-shaped groove to receive a screw point, a common flat-face wheel having a sharp corner may be used.

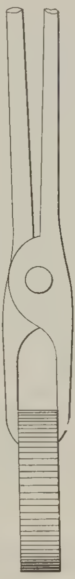


Fig. 25

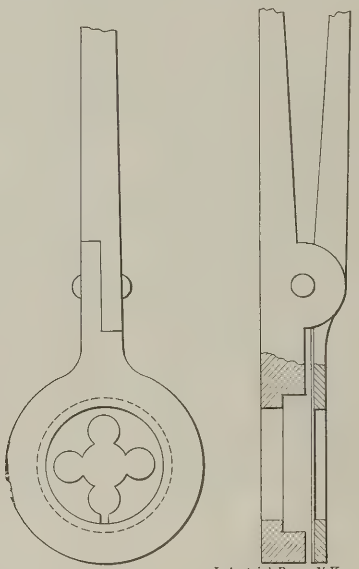


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Fig. 26

Before hardening, the diameter of the screw to be cut and the lead should be plainly stamped on the die. This should never be overlooked, as the omission might occasion a vast amount of trouble.

It is customary in shops where the quantity will warrant it to make the blanks on a screw machine, turning them to size with a box tool, and cutting off sufficiently thick to allow of finish on both sides. Where the number does not warrant making them in this manner, a piece of steel may be turned to the desired diameter and the blanks cut nearly off with the parting—cut-off—tool, as shown in Fig. 27.

Spring Dies.—In some shops this form of die is used very extensively, while in others it is entirely unknown. It is, however, easily made and answers the purpose nicely. When it is necessary to work very closely to size it is best to run two dies on the screw—a roughing and a finishing die.

The shape of the die (Fig. 28) is such that a collar is used to keep the cutting edges from springing. On account of its form this collar is known as a clamp collar, and by its use the die may be adjusted to size. Here, again, when many dies are made, considerable time may be saved by using a holder whose shank fits the hole in the spindle of the lathe. The holder is similar to that described for holding round dies, except that the opening is made to accommodate the dies under consideration. As this form of die is made much longer than the others there must be an opening in the back end somewhat larger than the size of the screw to be cut, so that the length of thread may be no greater than the amount previously mentioned—1¼ times the size of die.

The stock is first turned to size, and cut off to length, then placed in the holder, the large hole in the back end drilled to the desired size, and the end faced true. It is next reversed in the holder, the end squared to length, centered and drilled and tapped. Then it is removed from the holder and milled to form the cutting edges. After drilling and reaming and *before* tapping the end of the hole may be chamfered back for three or four threads.

When milling to form the cutting edges, which for ordinary work should be four in number, use a 45-degree *double-angle* milling cutter. This cutter should be of sufficiently large diameter to produce a cut deep enough for the cutting edges to spring when acted on by the clamp collar. After the cutting with this milling cutter, clearance is given to the chamfered cutting edges by means of a file.

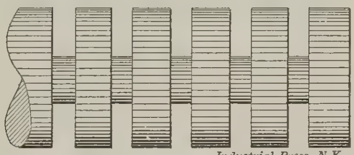
Industrial Press, N.Y.

Fig. 27.

For hardening, heat very carefully in a muffle furnace, or in a tube in an ordinary fire, and dip in a bath of lukewarm water or brine. Draw the temper to a full straw color by standing the tool on a hot plate, with the cutting edges uppermost. When the die is drawn sufficiently check in warm oil; a tool checked (when the temper is being drawn) by plunging in cold water is made brittle.

Die holders for use in connection with either round dies or spring dies may be made according to instructions given for releasing holders for holding taps used in screw machines, except as regards size and depth of hole for dies.

The clamp collars can be cut from solid stock, but if many are required drop forgings can be used or a pattern may be made and the collars cast from brass, or cast steel, making the hole small enough to finish to size with a reamer. Then it is drilled and tapped for the adjusting screw, and split, and is ready for use, unless it is thought best to finish the surface. In most shops, however, on account of the cost, it is not considered advisable to finish any surfaces where it is not absolutely necessary. Of course they are made smooth enough to prevent chips sticking to them, and so they can be wiped without waste adhering to the surface, but beyond this, polish is not allowable as a rule.

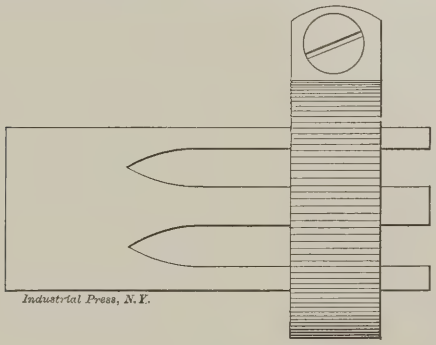
Industrial Press, N.Y.

Fig. 28.

Dies With Inserted Blades.—It is not feasible to attempt to make small dies with inserted blades; but for dies larger than 1¾ or 2 inches in many shops a ring of machine steel or cast iron is made, having slots in which are inserted blades made of tool steel. The first cost of a die may not be any less when made by this method, but the cost of new blades is much less than the cost of a new solid die. Then, again, unless large dies are pack-hardened there is considerable danger of cracking, which is, of course done away with when only the blades are hardened.

The slots to receive the blades should be so made that the front edge of the blade will be radial, as was shown in Fig. 3 in the June issue. The slot must be wider at the bottom than at the top, as shown, in order that the blade may be drawn onto its seating and kept from drawing away from it when in use.

Inserted blade dies may be made either solid or adjustable, as desired. When made solid, they are tapped with a hob the same size as screw to be cut by the die; when made adjustable they should be tapped with a hob a few thousandths of an inch larger than the size of the screw, to provide clearance to the land when cutting. For adjustable inserted blade dies the method of adjusting for size varies in different shops. Some mechanics consider it best to make them to adjust as shown in Fig. 29, while others claim best results if provided with adjustment as described under adjustable dies, in the beginning of this article. When made as shown in Fig. 29, it is necessary to provide a flat spot on the side to start drilling on, or else the beginner will experience considerable trouble. This flat surface may be made with a chisel, or an end mill may be used in a milling machine, the die held in the vise and the mill fed into the die, as shown in Fig. 30. Should many dies of a size be required a jig must be provided, for use in drilling this hole.

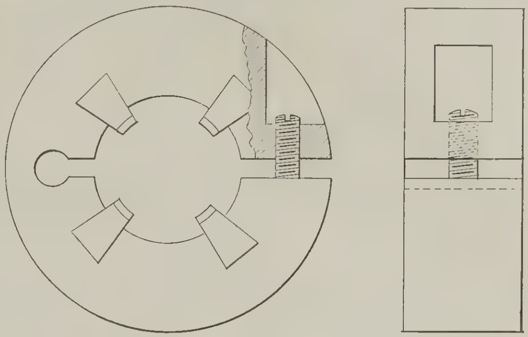
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Fig. 29.

* * *

The quest for a copper-hardening process has absorbed the energies and thought of many misguided blacksmiths and others, who have in some way been led to believe that the discovery of the secret of this so-called "lost art" would immediately place them on some pinnacle of fame and at the same time fill their pockets with a goodly supply of the coin of the realm. Apparently there is some reason for believing that the art of hardening copper is one that never existed save in the imaginations of certain historians who thought that because certain things were done in the copper or bronze age requiring edged tools, there must have been a copper-hardening process. Presumably these ancient people also had iron and steel tools, but all traces of these have vanished, of course, simply because of rust. The New York *Times* quotes from a letter received from Mr. Alexander Del Mar, a mining engineer of New York City, as follows: "No tools of tempered copper that will, for instance, cut rock, have ever been found. I have personally inspected some of the most ancient rock mines in the world in Spain, Cornwall, Pannonia (Hungary), Asia Minor, and elsewhere. The marks upon them are all those of steel tools." It is difficult to see how a practical copper-hardening process could be made to be of any particular commercial value in this age of far cheaper and more plentiful steel. Copper tools could apparently have only one superior characteristic and that is freedom from corrosion, but no one expects to leave fine-edged tools out in the rain and the coarser ones do not seem to suffer badly from a little neglect in that way.

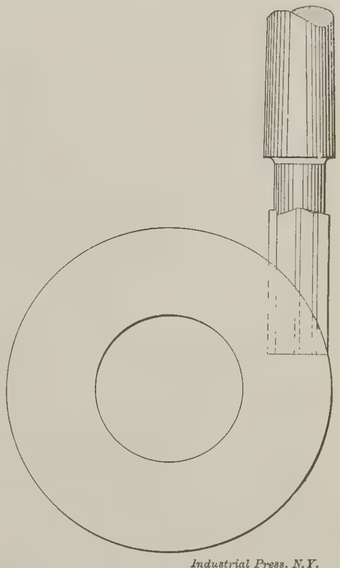
Industrial Press, N.Y.

Fig. 30.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1904.

NET CIRCULATION FOR JUNE, 1904,—22,764 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

Mr. Charles H. Haswell, who celebrated his 95th birthday May 23, is undoubtedly the oldest engineer in active practice. While he is perhaps best known to the public as the author of the Mechanics' and Engineers' Pocketbook, he is an engineer of no little reputation and one who has been identified with many notable undertakings for the United States Government. His Pocketbook has reached the enormous sale of 130,000 copies, having passed into the 70th edition, which is now in press.

* * *

It has been freely predicted that the application of electric motors to the driving of machine tools would eventually work a revolution in their design, especially where each tool has its own motor. So far the change has not been much in evidence, save in isolated cases, and this is largely, we believe, because of the limitations of the electric motor and partly because of the conservatism of builders and users of such tools. When users of machine tools cease to demand a range of speeds on, say, a 24-inch lathe, that shall permit any diameter from ½ inch up to the full capacity of the lathe to be handled at the most efficient speed, both for turning and filing, then there will be a better chance for the motor drive to effect its revolutionary work. And the same condition applies to radial drills. With the ideal motor the radial drill would consist of little more than a post and a swinging arm, the latter carrying the spindle, feed mechanism and motor. There would be no splined shafts or bevel gears for transmitting motion around corners since the motor would be applied directly to the spindle, with provision, of course, for the interposition of back gears. This design has already appeared, but is making slow headway. But does the simplest possible method of motor connection apply in the case of the planer? That is, should a reversing motor be connected directly to the screw of a Sellers planer, or the pulley shaft of a spur gear planer, the reversing of the platen being effected by reversing the motor? This latter scheme is being tried, but is it not imposing more on a motor than should consistently be asked, especially on short strokes? The rush of current must necessarily heat such a motor, unless absorbed by resistance coils, which would be wasteful.

* * *

In the course of an address on patents and inventions delivered before the engineering students at Lewis Institute, Chicago, Mr. S. G. McMeen said that the industrial greatness of this nation is in large measure due to the existence of good patent law and to the encouragement which has been given to inventors by its operation. The inventive ability of a people lies not alone in its facility in finding ingenious ways of setting things together to achieve results, but also in its wisdom to see clearly industrial and social needs. In the instance of the inventor who produced the cranberry sorter, every one in the cranberry industry knew the need of sorting so that cranberries for market would contain no soft ones; it required a mental aptitude to see an immediate possibility of invention in the circumstance that when cranberries were spilled down the back steps only the sound ones hopped from step to step, the soft ones stopping early.

In the further course of his remarks Mr. McMeen referred to the abandonment of inventions. An applicant may not secure a patent in this country if his invention has been in actual public use for two years or more before he makes his application. Interesting questions sometimes arise as to whether the use has been really public or might not have been wholly for the purpose of testing the efficiency of the invention by a continued test. A form of sidewalk which had been in use for two years was held not to vitiate the rights of the applicant because, although distinctly in public use, the excellence of its form could only be proved to the inventor by actual trial and could not be considered to be a final test unless continued for a considerable time. In another instance of an article of wearing apparel distinctly not public in its use, a period of two years was held wholly to vitiate the rights of the applicant because very much less than two years should have sufficed to enable him to decide whether the invention was or was not in a proper form for filing his application.

* * *

MIS-DIRECTED INVENTIVE GENIUS.

The driving of marine craft and their design have been fruitful fields for the inventor, but, unfortunately, the results of inventive genius in this direction have been largely negative because certain laws were not understood, or were ignored. For instance, it has been a quite common impression that a vessel can be driven more economically and at higher speeds by a water jet than by a propeller, or paddlewheels. And almost invariably the inventors have proceeded on the assumption that the higher the velocity of the water jet the more effective it would be as a propulsive agent. Hence the general run of these experiments has been with jets of small diameter and high pressure. Needless to say they have invariably failed. The reason is not far to seek. A vessel is propelled by the reaction of a certain volume of water projected backwards. It is easily proven that the larger the volume of water projected backward the greater the propulsive effort transferred to the vessel. It is simply another illustration of the law that action and reaction are equal and in opposite directions. The heavier the gun in proportion to the bullet the less the kick, and *vice versa*. It is the kick that is wanted with the vessel; hence the prime necessity for projecting backwards the greatest possible volume of water—and this can be done with the ordinary propeller more economically, perhaps, than in any other way. Again there is the type of craft known as the water-plane, in which the effort is to ride *over* the water rather than cutting *through* it. In this type there has also been disappointment. A vessel floats simply because of its displacement of an equal weight of water, and it must displace this weight whatever its shape, whether round, square, oblong or flat. The resistants to motion are skin friction, inertia of the displaced water and the air. Beyond a certain ratio it is useless to lengthen a vessel of a given displacement in proportion to its width, for what is gained in the matter of relative speed by displacing the water gently is lost by the added skin friction of such a boat. The displacement is a function of the volume, but the skin friction is a function of the wetted area; the former cannot be changed, but the latter is greatly affected by the shape, and a plane is the worst shape, as it gives the largest proportional wetted surface. Hence what a water-plane craft may gain in the matter of advantageous displacement of the water as it skims over it, is largely or entirely neutralized by the additional skin and wind resistance.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The winner of the international automobile race at Sallburg covered the course of 350 miles in the almost incredible time of 5 hours, 50 minutes and 3 seconds, or almost exactly at the rate of one mile a minute for the entire course. Such exploits put to shame the locomotive, which rarely makes sustained runs at such high speed on smooth rails.

That interesting little periodical, *The Locomotive*, which has been issued monthly since 1867 by the Hartford Steam Boiler Inspection & Insurance Company, will hereafter appear as a quarterly. The quarterly numbers will contain a larger number of pages than the monthly and the matter will be more closely confined to its field, so that the readers will get about the same number of pages of steam engineering matter as heretofore.

A novelty in car construction is that of the Bettendorf oil tank car which has no supporting underframe, the cylindrical shell of the tank forming the sole basis of longitudinal and transverse strength. The upper portion of the tank consists of five sheets joined by circumferential riveted seams, but the lower part is made up of one sheet running the whole length of the tank, thus avoiding a circumferential seam in the part which is subjected to severe longitudinal stresses. The tank has a capacity of 10,000 gallons and the car complete, without loading, weighs 35,000 pounds. To keep the center of gravity low the coupler and draft rigging are mounted in a special steel casting which is riveted to the lower part of the shell and which projects into the interior so that the center line of draft is several inches above the bottom of the tank. This casting also forms the center and side bearings for the truck.

We have received from the Mechanical Engineering Department of the University of Illinois a copy of the fourth edition of their extension of the Dewey Decimal Classification, applied to mechanical and railway engineering. In the Dewey system of indexing the general classes are: 00, General Works; 100, Philosophy; 200, Religion; 300, Sociology; 400, Philology; 500, Natural Science; 600, Useful Science; 700, Fine Arts; 800, Literature; 900, History. The main subdivisions of a class are indicated by numbers, the hundreds place of which indicates the class. Thus Mathematics is 510, which shows that it is in the class of Natural Science, and the divisions of Mathematics are, for instance, 511, Arithmetic; 512, Algebra; 513, Geometry, etc. Mechanical Engineering is 621, showing it is in the class of Useful Science and in the subdivision 620, or Engineering. Steam Engineering is 621.1, and under that we have 621.11 for the Mechanism of the Steam Engine, and again 621.111 for the Reciprocating Parts; 621.112 for Shafts, Journals and Bearings. Locomotives are designated 621.13; details such as smokebox and pipe, 621.1334, etc.

In a report from Beirut, Syria, United States Consul Ravndal writes at length on irrigation and windmills in Syria. He mentions the ancient devices employed for raising water; among them the noria, or wheel with rows of buckets on its periphery. When used in fells or still water these wheels are turned by oxen or mules and sometimes by man power, but in rivers advantage is taken of the current to turn the wheel, floats or paddles being secured to arms so that it acts in undershot waterwheel fashion. This latter system of wheels is seen on a grand scale at Hums, Hamath and all along the Orontes. The wheels are of enormous size; the diameter of some of those at Hamath is 80 or 90 feet. The great advantage of this apparatus is that it is driven by the river itself. Small paddles are attached to the rim, and the stream is turned upon them by a low dam with sufficient force to carry the huge wheel around with all its load of ascending buckets. "There is perhaps," says a distinguished writer, "no hydraulic machinery in the world by which so much water is raised to so great an elevation at so small an expense. Certainly I have seen none half so picturesque or so musical. These wheels, with their enormous loads, slowly revolve on their groaning axles, and all day and all night each one sings a different tune, with every imaginable variation of tone, loud, louder, loudest, down to the bottom of the gamut—a concert wholly unique and half infernal in the night, which, heard once, will never be forgotten"

A consular report calls attention to the investigation and experiments that have been carried on in Germany with superheated steam locomotives. They have established the fact that superheated steam can be used efficiently with locomotives as well as with stationary steam engines. When the greatly superior efficiency of superheated over saturated steam is taken into consideration there seems strong reason to believe that the great success already obtained by the stationary engine will be repeated with the locomotive—that materially superior economy in power will be attained by the use of superheated steam, which will in time come into general use for locomotives. As far as is known there is only one locomotive using superheated steam in America, and it is equipped with a Schmidt superheater and is being experimented with by the Canadian Pacific line. It is believed that it is well worth the while of American technical and railroad men to give careful consideration to the experience obtained by the Prussian State railroad in the utilization of superheated steam on locomotives and to examine the locomotives equipped with the Schmidt and Pielock superheaters that are being exhibited at St. Louis.

In an article, "Chill Rolls," in the *Iron Age*, Mr. B. E. V. Luty says that the standard dimensions of tinplate rolls in this country are 26 inches diameter, 32 inches long in the body and 20 inches diameter in the necks. The depth of chill is about ⅞ inch, but it was formerly only ½ to ⅝ inch. The life of a chill roll is only from 90 to 120 actual working days for tinplate or ordinary sheet rolling, running at 30 revolutions per minute. But many good rolls are broken before they are worn out. The reasons for breaking are somewhat indeterminate, although they may be included under three heads: 1. Casting strains. 2. Excessive pressure on the roll from the material being worked. 3. Heat strains produced in the roll by irregular working. While theoretically the pressure necessary to break rolls by excessive pressure is something enormous, they are frequently broken in this way. It is calculated by the formula

$$W = \frac{4f}{l}\,0.0982d^3 \text{ in which}$$

W = load in pounds, applied at the center,
f = fiber strength
l = distance between supports
d = diameter

so that on a standard roll the load applied to the center necessary to break it would be 2,887,000 pounds, taking the fiber strength to be 20,000 pounds per square inch.

THE TAYLOR HYDRAULIC COMPRESSOR AT TAFTVILLE, CONN.

In the September, 1902, issue a brief review was given of some of the systems employed for using the trompe or hydraulic principle for compressing air, and among them was the Taylor 1,000 horse power hydraulic compressor that had recently been installed at Magog, Quebec. A 1,500 horse power Taylor air compressor has since been placed on the Quinebaug River at Taftville, Conn., for supplying compressed air to Norwich, Conn., a city of about 20,000. Its maximum capacity is 12,000 cubic feet of free air per minute compressed to a pressure of 90 pounds. With 23-foot head about 800 cubic feet of water per second is used. A writer in *Compressed Air* says:

"With a 1,500 horse power air compressor is usually associated in one's mind a fine large engine room, well filled with moving machinery, so that the first view of this power house is somewhat disappointing. A small, low building perched upon one end of the dam, to all appearances the gatehouse and much smaller than many of them, is the only building in sight. Upon entering this one sees a vast quantity of water flowing in from the forebay toward the center and disappearing down a tube some 10 feet in diameter. Suspended above this is a frame supporting several hundred tubes about one inch in diameter and some two or three feet long, their lower ends immersed for a few inches in the water. These are the air tubes and the strong suction action exerted by the water can be easily felt by placing a finger upon the top of one.

"The flow of water is controlled by a set of gates which can be controlled either by a small turbine wheel or by hand. The vertical tube extends downward some 225 feet below the surface of the water in the tail race in order to get the proper submergence for the 90 pounds air pressure required. In the separating chamber is a blow-off pipe several inches in diameter. Normally the bottom of this is sealed by the water in the chamber, but should a surplus of air accumulate the water level falls and the air passes off through the pipe. This stream of air and water is shot some 200 feet and looks as though a small geyser were at work.

"From the compressor a 16-inch cast-iron pipe carries the air to the city of Norwich where it is distributed to several mills and other power users. A very noticeable feature of the air is its absolute dryness. A looking-glass held against a jet of it will not show a trace of moisture. It is claimed to carry less than one-third of the moisture of air compressed by any other means and to have been thoroughly washed and cleansed by its intimate mixture with water during compression. At present the air is chiefly used by the mills in engines of from 100 horse power down. These engines were formerly operated by steam and are generally of the slide valve, throttling governor type, and use much more air than they should, but any engines installed in the future will no doubt be of a construction economical in the use of air. The charges at present are arranged for each individual case, but it is hoped shortly to get upon a meter basis."

THE IMPORTANCE OF A HIGH VACUUM FOR THE STEAM TURBINE.

Abstract from Paper read by Mr. Charles A. Parsons before the British Institution of Electrical Engineers, May 12, 1904.

A good vacuum is of great importance in a turbine, as the expansion can be carried in the turbine right down to the vacuum of the condenser, a function which is practically impossible in the case of the reciprocating engine, on account of the excessive size of the low-pressure cylinder and also of the ports, passages and valves which would be required. Thus in a turbine the benefit derived from a good vacuum is much more than in a reciprocating engine, every 1 inch of vacuum between 23 inches and 28 inches affecting the consumption on an average about 3 per cent. in a 100 killowatt, 4 per cent. in a 500 kilowatt, and 5 per cent. in a 1,500 kilowatt, the effect being more at high vacuums and less at low. It is thus seen how a good vacuum is of importance in a turbine plant, and in this regard it may be well to look into the conditions necessary for obtaining the same. The first point is to avoid all air leaks, and this is easily accomplished in a turbine plant, as there are no packed glands and stuffing boxes to leak. The only places where leakage of air is possible are where the turbine spindle comes out of the cylinder, and here leakage of air is rendered very small by packing the glands with steam, so that any leakage which takes place is steam and not air. The next is to have a suitable condenser, and in this regard sufficient area must be allowed by suitable arrangements of the tubes, and also ample way for the steam between them for proper velocities of the water in the tubes, sufficient supply of cooling water and efficient means of cooling the condensed water so as to keep the air-pump cool, and full provision for extracting, by the air-pump and other means, the inevitable small quantity of air which must leak in. By attention to these requirements it is unnecessary to increase the size of the condenser beyond that used in ordinary practice, so that in the case of the most recent condensers for steam turbines from 10 to 12 pounds steam is condensed per square foot per hour; and at this rate of condensation, vacuums of from 27½ inches to 28 inches, with barometer 30 inches, can be obtained at full load. The amount of cooling water generally allowed is about 50 times the full-load steam consumption, which will increase the vacuum under normal conditions by about ¾ inch or 1 inch over that obtained by the usual 30 times the steam used. If we allow 14 feet total head on the circulating pump due to lift, and for friction in the pipes and condenser, etc.—which in most cases is excessive, especially where the return pipe is sealed—with 50 times the steam consumption in a plant taking 18 pounds steam per kilowatt hour, and assuming 50 per cent. efficiency in the pump and motor, the power used by the circulating pump is only 1 per cent., and with circulating water 30 times the steam consumption it would be 0.6 per cent., a difference of only 0.4 per cent., such a small difference as not to be comparable with the gain of 4 per cent. to 5 per cent. in the turbine by the use of increased circulating water.

With regard to extracting the air, a great improvement has been effected by the use of a vacuum augmentor which has been recently introduced. In it the air-pumps are placed about 3 feet below the bottom of the condenser. From any convenient part of the condenser, preferably near the bottom, a pipe is led to an auxiliary condenser, generally about one-twentieth the cooling surface of the main condenser, and in a contracted portion of this pipe a small steam jet is placed which acts in the same way as a steam exhauster, or the jet in the funnel of a locomotive, and sucks nearly all the residual air and vapor from the condenser and delivers it to the air-pumps. A water seal is provided to prevent the air and vapor returning to the condenser. Thus, if there is a vacuum of 27½ inches to 28 inches in the condenser, there may be only about 26 inches in the air-pump, which, therefore, need only be of small size, the jet compressing the air and vapor from the condenser to about half, or a little less, of its original volume. The small quantity of steam from this steam jet, which is only about 1½ per cent. of that used by the turbine at full load, together with the air extracted, is cooled down and condensed by the auxiliary condenser, which is generally supplied with water in parallel with the main condenser. In this connection it should be observed that condensation in a condenser takes place much more rapidly and effectually if the air is thoroughly extracted than if there is much air present, as the air seems to form a blanket round the tubes and retards the steam getting to them.

CORROSION OF BOILER TUBES.

Journal American Society of Naval Engineers, May, 1904.

In January, 1901, the Bureau of Steam Engineering of the Navy Department directed the Naval Inspector of Engineering Material for the Pittsburg District to carry out a series of tests in order to determine the relative corrodibility of lap-welded Bessemer steel, lap-welded iron, seamless cold-drawn steel and seamless hot-drawn steel boiler tubes. All the samples were secured from the National Tube Company and the tests were conducted in that company's laboratory at McKeesport, Pa.

The tests were conducted in twelve tanks, each tank containing sixteen samples which were taken from the top, middle and bottom of the steel ingots. These samples were shifted about so that at the end of a period of sixteen weeks, each sample should have occupied every position in the tank in which it was placed. The tanks were porcelain lined and were partially filled with distilled water through which compressed air was forced by a compressor. After the tests had been carried on for sixteen weeks the samples were washed, dried, weighed, and photographed to determine the relative corrosion in each case. The samples were made six inches long, from tubes made especially for the purpose, and were all of the same diameter, three inches outside, and of the same gage, No. 9 B. W. G. Each sample was a half of a six-inch tube cut in two longitudinally. Additional tanks were also provided, in one of which eight samples were immersed in a strong alkaline solution—potassium hydrate (KOH).

After each period of sixteen weeks the samples were carefully washed and dried, and weighed. The results were tabulated and an average of the losses per square inch of surface area was made. These averages are as follows:

Average Loss in Grammes.

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. (4th 16 weeks.)
1. Hot-drawn seamless steel	.3034	.5333	.3510	.5070
2. Lap-welded Bessemer steel	.3147	.4950	.4043	.4945
3. Cold-drawn seamless steel	.3268	.5795	.4595	.5076
4. Charcoal iron	.3326	.5896	.3966	.4893

The difference in the amount of loss in the four classes of tubes is not great, that of the charcoal-iron tubes, which had the greatest loss, being, roughly, 6.3 per cent. more than the loss of the hot-drawn seamless tubes, which suffered the least.

Considering the three grades of the hot-drawn seamless tubes alone, it was found that the average losses per square inch of surface area were:

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. 4th 16 weeks.
Tubes from the top of ingot	.3205	.5700	.3708	.5213
Tubes from the middle of ingot	.3121	.5339	.3571	.5108
Tubes from the bottom of ingot	.2776	.4960	.3254	.4906

The difference in the losses of these three grades is very marked. At the end of the first sixteen weeks those from the top of the ingot lost 15.4 per cent. more and those from the middle of the ingot 12.4 per cent. more than those from the bottom of the ingot. At the end of thirty-two weeks those from the top of the ingot lost 14.9 per cent. more and those from the middle of the ingot 7.6 per cent. more than those from the bottom of the ingot. At the end of forty-eight weeks those from the top of the ingot lost 15.9 per cent. more and those from the middle of the ingot 9.7 per cent. more than those from the bottom of the ingot. At the end of sixty-four weeks those from the top of the ingot lost 6.2 per cent. more and those from the middle of the ingot 4.1 per cent. more than those from the bottom of the ingot—the loss from the bottom samples being less, probably on account of the lesser amount of impurities and greater density of the metal of the ingot in this part.

Of the three grades of lap-welded Bessemer tubes the average losses per square inch were:

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. (4th 16 weeks.)
Tubes from the top of ingot	.3686	.5268	.4112	.4966
Tubes from the middle of ingot	.2941	.4826	.3939	.4891
Tubes from the bottom of ingot	.2814	.4756	.4079	.4977

The difference here is even more marked for the top of the ingot than in the case of the hot-drawn tubes. At the end of the first sixteen weeks those from the top of the ingot lost 30.98 per cent. more and those from the middle of the ingot 4.51 per cent. more than those from the bottom of the ingot. At the end of thirty-two weeks those from the top of the ingot lost 10.76 per cent. more and those from the middle of the ingot 1.47 per cent. more than those from the bottom of the ingot. At the end of forty-eight weeks those from the top of the ingot lost .8 per cent. more and those from the middle of the ingot 3.43 per cent. less than those from the bottom of the ingot. At the end of sixty-four weeks those from the top of the ingot lost .22 per cent. less and those from the middle of the ingot 1.72 per cent. less than those from the bottom of the ingot; the great variation in loss of these samples being due probably to a greater amount of impurities of the metal of the ingot in this heat.

The losses per square inch of area were:

	After 16 weeks. (1st 16 weeks.)	After 32 weeks. (2d 16 weeks.)	After 48 weeks. (3d 16 weeks.)	After 64 weeks. (4th 16 weeks.)
Tubes from the top of ingot	.3288	.6166	.4796	.5525
Tubes from the middle of ingot	.3120	.5278	.4451	.4498
Tubes from the bottom of ingot	.3075	.5645	.4451	.5192

When the results obtained from the cold-drawn seamless tubes are investigated, a similar result as in the former cases appears, except that the losses in each series of sixteen weeks is much smaller than in the other cases.

The difference in the losses of these three grades is quite marked; at the end of the first sixteen weeks those from the top of the ingot lost 6.9 per cent. more and those from the middle of the ingot 1.4 per cent. more than those from the bottom of the ingot; at the end of thirty-two weeks those from the top of the ingot lost 9.2 per cent. more and those from the middle of the ingot lost 6.49 per cent. less than those from the bottom of the ingot; at the end of forty-eight weeks those from the top of the ingot lost 7.7 per cent. more and those from the middle of the ingot were equal to those from the bottom of the ingot; at the end of sixty-four weeks those from the top of the ingot lost 6.4 per cent. more, while those from the middle of the ingot lost 13.3 per cent. less than those from the bottom of the ingot.

It appears at first glance that these tubes corroded more uniformly than the two former kinds, but an examination of the averages for the separate tanks shows that this is not the case in the individual tanks. The averages for the individual tanks, both for the lap-welded Bessemer and for the cold-drawn seamless tubes, show the same general results as are shown by the general averages for the three tanks as to the relative losses of the tubes from the top, middle and bottom of the ingot.

No reasonable cause can be assigned for this variation from the results that were obtained in the cases of the hot-drawn seamless tubes, unless it may possibly be due to the hot-swedge rolling and cold drawing to which the metal is subjected. This working which the metal receives may have a greater tendency to reduce the metal of the ingot to a more uniform density throughout than the process of the lap-welded and seamless hot-drawn tubes.

In the additional tank to the water of which the KOH was added at the beginning of the experiments, the average loss for the eight samples, all lap-welded Bessemer steel, was only .0997 grammes per square inch at the end of the first period of sixteen weeks. As this tank contained samples from the top, middle and bottom of the ingot, and the conditions were, with the exception of the alkali, the same as in the other three tanks containing the lap-welded Bessemer steel tubes, the results obtained from it can be fairly compared with the average of these three tanks. The average loss of these tanks was .31500 grammes per square inch of specimen, so that the loss in the alkaline tank was only 31.6 per cent. of that with fresh water. This result indicates strongly the wisdom of keeping the water in boilers slightly alkaline at all times, as a safeguard against deterioration from oxidation. While the result obtained would seem to indicate the advisability of using cold-drawn seamless tubes, looking at it from the point of loss by corrosion alone, yet in making the choice other points must be considered, as, for instance, not only the amount of corrosion but also the nature of the corrosion, whether spread over a large area or concentrated in pits. Some of the tubes showing a large loss may have this loss spread over a large amount of surface and only superficial, while others showing a small loss may have this loss concentrated in three or four pits, which would destroy the value of the tubes much more rapidly than in the other case.

HIGH-SPEED STEAM LOCOMOTIVE TESTS IN GERMANY

From United States Consul-General Mason, Berlin, Germany, Consular Report No. 1972.

In the several reports from this consulate during the past two years describing the conditions and results of the elaborate experiments in high-speed electrical traction which have been conducted on a section of carefully prepared track between Marienfelde and Zossen, near Berlin, repeated reference has been made to the fact that an equally thorough and interesting series of tests would in due course be made with several specially constructed steam locomotives, in order to secure a basis for conclusive comparisons between the two forms of power for high-speed traffic over long distances. The question to be decided by these deliberate and carefully prepared trials was whether, with the existing conditions of climate, distances between large cities, grades, curves, and the present standard of track and bridge construction in Germany, the speed of express passenger trains could be safely and economically increased to 70 or 80 miles per hour and, if so, whether steam or electricity would prove preferable as a motive power. Would the German "Blitzzug" of the future be hauled by an electric motor or a steam engine so enlarged and improved as to meet the highest requirements of modern railway practice?

The electric motor trials were completed, as will be remembered, during the autumn of last year, with the net result that the two motor cars obtained speeds of 117.32 miles per hour—or nearly 2 miles per minute—without injury to the car or motor, without undue strain upon the track or discomfort to passengers. This upon a straight, nearly level track 14.5 miles long, and of the heaviest and most solid and careful construction, with inside guard rails to minimize the effect of lateral motion at high velocities. But as the railways of Germany involve all the usual variations of grade and frequent curves of a radius as low as 520 yards, any such pace as 117 miles an hour was and must long remain outside the limits of actual practice. It remained for the new locomotives to demonstrate the efficiency of steam up to 80 or 85 miles an hour, the apparent limit of speed development under existing conditions.

Experiments with Steam Locomotives.

The track having been carefully examined and the deteriorating effects of the electric-motor-car trials noted and repaired, the experiments with steam locomotives began about the end of February and were continued until a few days ago. The tests included engines of four different types, each built by a different German firm, or company. In order to make the conditions as nearly as possible those of actual service, the load consisted of six vestibule cars of the standard D type, weighing about 30 tons each, one of which had been equipped with instruments to measure and record speed, oscillation, and the pull exerted by the engine at each part of the run. Each engine was first tested with the full train, then half of it was detached and another series of trials made with three cars only. This latter series was in compliance with the scheme described in a consular report, "The Express Train of the Future," by which it was proposed to divide the fast long-distance passenger-train service into units of three cars each, capable of carrying 100 passengers with all facilities for their comfort by day or night.

The first trials were those of a locomotive built by the Egestorf Machinery Company, at Hanover. It is of the same general model as the "Atlantic" type in the United States—that is, carried on ten wheels, viz., the four-wheeled forward truck, then the two pairs of coupled drivers, and a pair of trail wheels under the cab to sustain the after-portion of the boiler, which is of extraordinary size and large heating surface. This machine, with the train of six cars, attained an average speed of 68.97 miles per hour throughout the run, and with three cars a pace of 79.41 miles an hour.

The second machine, of Grafenstadt construction, is a compound locomotive, likewise of the Atlantic type, in which the cylinders are placed far back and the piston head geared by a short connecting rod to the crank pin of the rear driving wheel. This engine made with the full train a run of 73.32 miles and with three cars 76.42 miles an hour, and showed good results as to fuel and steam consumption.

The third contesting machine was an eight-wheeled compound engine equipped with Schmidt's device for superheating steam. It was designed by Baurath Garbe and built by the well-known firm of A. Borsig, at Tegel, near Berlin. This engine was not built specially for these trials, but is one of a number of the same type which have been constructed by the same firm and supplied for service to the royal Prussian railway administration. The driving wheels are 78 inches in diameter; heating surface, 963 square feet; surface of superheater, 288 square feet; normal working pressure, 176.4 pounds to the inch; and weight, when ready for service, 120,051 pounds avoirdupois. This engine attained with the full train 79.53 miles and with three cars a speed of 84.5 miles an hour, the energy developed being about 2,000 horse power.

The fourth competitor was an engine of a wholly original type, designed by Chief Engineer Wittfeld, of the Prussian railway administration, and built by Messrs. Henschel & Sons, of Cassel. Before being brought to Berlin it was tested on one of the State lines near Göttingen, and since the trials were finished it has been dismantled and shipped for exhibition at the World's Fair in St. Louis. Its most striking peculiarities are that it is so built that the engineer stands in front within a glazed cab like the motorman of an electric car, and both engine and tender are covered with a sheathing of sheet iron with glazed windows and so arranged as to provide a covered passage from front to rear. The engine is carried on twelve wheels, viz., a four-wheel bogie in front and rear and between them the two pairs of drivers, coupled in the usual manner. This arrangement is for the purpose of securing a smooth steadiness of motion despite curves or irregularities of track surface. The engine is of the compound type, the high-pressure cylinder being located midway between the side frames, where its piston connects with an inside crank on the forward driving shaft. The low-pressure cylinders, of which there are two of equal diameter, are external and drive two outside cranks set parallel to each other and on the same side of the axle 90 degrees from the inside crank that connects with the high-pressure cylinder. This secures an even balance between the reciprocating parts, from which important results have been expected. The boiler is, from the European standpoint, enormous, having 2,766 square feet of heating surface, and it is calculated that, with a coal consumption of 2.5 pounds per horsepower hour, it will develop about 1,775 horsepower. It weighs 76.8 tons and cost $23,800. The tender weighs 47 tons and carries 7 tons of coal and 4,400 gallons of water, which it is equipped to take up at speed, as is done on some lines in the United States. At the recent tests this engine slightly surpassed all its competitors, attaining a speed of 79.53 miles per hour with six cars and 85.12 miles with half that number. While, therefore, its speed with the full train was the same as that of the Borsig superheater, the Cassel machine did 0.62 mile better with the light load, a difference so slight that it might easily have been influenced by varying conditions of wind.

This in substance is what is now publicly known concerning the results of these most interesting trials. The comparative advantages of all the contesting engines—their relative consumption of fuel and steam, their general efficiency at high velocities, and their smoothness of movement on curves of different radius—will be known only to the Government experts, until the whole mass of notes and records made during the experiments and subsequently on other portions of the line shall have been formulated and published.

Among the incidental demonstrations made by the tests was the fact that with the pneumatic brakes now in use on German vestibule cars it required a full minute and a distance of 1,093 yards to stop a train of six cars running at 85 miles an hour. German first-class trains are equipped for a maximum speed of 52.8 miles an hour, and their brakes are capable of stopping a train running at that speed on level track within a distance of about 433 yards. If, therefore, any approach to the higher speeds which will be made possible by these new types of locomotives should be adopted, the change will involve important modifications in brakes and signal systems, which are based on present limitations of speed and braking power.

Comparison of Cost of Motive Force.

Pending the preparation and issue of the official report on which the ultimate conclusions will be based, a Berlin engineer, Dr. Reichel, has given some interesting comparisons of cost between steam and electric traction from the standpoint of German practice and illustrated by the recent experiments with both motive forces. A steam train of five cars and a standard locomotive weighs 330 tons, seats 168 passengers, and uses at full speed 1,400 horsepower. The electric train of one motor car and four trail cars weighs 260 tons, seats 180 passengers, and utilizes 1,000 horsepower. Each train and engine costs for initial construction about $100,000. The operating cost of the steam trains is fixed by Dr. Reichel at 12½ cents per 100 seat kilometers, and 11½ cents, or 1 cent cheaper, for the electric train.

THE CURTIS STEAM TURBINE.

From a Paper by W. L. R. Emmet upon "The Steam Turbine in Modern Engineering," read before the June, 1904, meeting of the American Society of Mechanical Engineers.

The general purpose of the Curtis design is to produce results with a reasonable number of simple parts and at moderate speeds, while the Parsons turbine requires a very large number of small parts and the De Laval turbine employs excessively high speeds inapplicable to mechanical purposes without the use of speed reducing gearing.

Mr. Curtis' experiments on steam turbines had been going on for about four years before the General Electric Co. undertook to build any machines for service. At the end of that period, and at a time now about four years ago, the author first became connected with the enterprise, being asked to express an opinion concerning the value of the invention. Other engineers had reported unfavorably, and the discontinuance of work was a possibility. The opinion given was that the invention afforded great possibilities, particularly in the matter of simplicity and economy of production; that the development of commercial machines was justified by the experiments and should be begun at once, and that the development of high degrees of steam economy was to be expected with further experience.

This report led to the beginning of work on a larger scale; the first step being to build a 600 kilowatt unit, which was put into operation at Schenectady in November, 1901. The success of this machine led to the undertaking of commercial work on a large scale, and the experience so far obtained and a careful study of mechanical possibilities led to the adoption for this new work of radically new mechanical designs, applied to bucket and nozzle arrangements similar to those previously used and first recommended by Mr. Curtis. The first machines designed of this new type were a 5,000 kilowatt unit for the Chicago Edison Co., and a 500 kilowatt unit, the first of which was installed at Newport, R. I.

These machines are built with shafts in a vertical position; the total weight of revolving part being borne by a step-bearing at the foot of shaft, and shaft being steadied and aligned by three bearings, one at the top of generator, another near the foot of shaft, and a third between the generator and turbine. Many reasons led to the adoption of this arrangement which involved some untried features, but which afforded very great practical advantages. A careful consideration of designs indicated that the untried features involved little risk of serious difficulty, and experience has shown that this judgment was sound. Some of the important advantages of the vertical shaft type are as follows:

The relative positions of revolving and stationary parts are definitely fixed by the step-bearing.

The stationary part is symmetrical, easily machined and free from distortions by heat.

The shaft bearings are relieved from all strain, and friction is practically eliminated.

The shaft is free from deflection and can be made of any size without reference to bearings, which can be placed where convenient and operated with surface speeds, which would not be practicable with the horizontal arrangement.

These features make possible the use of a very short shaft, and consequently the longitudinal spacing of moving and stationary parts is very little affected by temperature differences.

The turbine structure affords support and foundation for the generator.

The cost of foundations is very small, and the solidity and alignment of foundation is not of vital importance.

Much floor space is saved.

All parts of the machine are conveniently accessible.

Failure of lubrication cannot injure the shaft or other expensive parts.

In the Chicago machine there are two stages, each stage having a single wheel which carries four rows of moving buckets. On the stationary part there are three rows of stationary buckets opposite each group of nozzles used. The shaft is in one piece from the step-bearing to the top of the generator. The wheels are of cast-steel mounted upon it with taper fits. The stages are separated by a cast-iron diaphragm which is fitted with valves which are now operated by hand, but which are being arranged to operate automatically; it being advantageous to constantly maintain a certain pressure relation between the stages.

The step-bearing consists of two cast-iron blocks, one carried by the end of the shaft and the other held firmly in a horizontal position and so arranged that it can be adjusted up and down by a powerful screw. The lower block is recessed to about half its diameter, and into this recess oil is forced with sufficient pressure to balance the weight of the whole revolving element. The amount of oil required is small. About 5 gallons per minute is used in the 5,000 kilowatt machine, but with a good alignment it could be satisfactorily operated with a much less amount. This whole structure is inside of the base, and a packing is used between the oil chamber and the base, so that oil or air cannot get into the vacuum chamber. A small steam pressure is maintained between the sections of this packing, in order that these objects may be accomplished with certainty. In many cases these same step-bearings have been operated with water instead of oil, in which case no packing is necessary, the water being allowed to pass into the base. In some of our latest designs water will be used exclusively; the lower surface of step-bearing being of wood and no packing being provided.

The extreme conditions to which these step-bearings are subjected, and a complete lack of precedent for such designs led at first to many doubts concerning the success of this feature. Experience has, however, shown that these doubts were without foundation. Practically no troubles or interruptions have resulted from this cause, and the step-bearings have shown a ruggedness and stability far beyond our expectations. Many of our turbines have been operated under more or less temporary conditions in incompleted stations, and there have been many accidental stoppages of step-bearing pressure while machines were running. In hardly any cases have such stoppages caused even an interruption of service. The step-bearing surface cuts immediately when lubrication is stopped, but the metal from it is removed very slowly and it has the power of re-establishing itself almost immediately when oil flow is again started. Our policy in adopting the vertical design and putting our dependence in step-bearing was to put all our eggs in one basket and watch the basket. We have now discovered that very little watching is necessary. In our newer designs we are providing a powerful brake, bearing on the lower surface of a chilled iron ring carried by the lower wheel. This brake can be conveniently operated from the outside, and can be used to take the whole weight of the revolving part in case the step-bearing support should fail. In ordinary operation the shoes of this brake will be set about .01 inch below the brake ring. It is thus in a position to receive the revolving part in case the step-bearing support should fail. Another and more important function of this brake is to stop the machine when it is desired to do so. One of the 5,000 kilowatt vertical shaft machines will run for four or five hours after the steam has been shut off, unless load is put upon it or a brake is applied.

THE DE LAVAL STEAM TURBINE.

From a Paper by E. S. Lea presented before the June, 1904, meeting of the American Society Mechanical Engineers.

The velocity of the steam jets in a De Laval turbine varies considerably, owing to change in pressure of the steam before entering the nozzles, to varying exhaust pressure, and to a greater or less degree of moisture or superheat in the steam. The lower limit of this velocity found in general practice might be considered as about 2,000 feet per second, which is obtained at a steam pressure of about 45 pounds per square inch, at an exhaust pressure equal to the atmospheric pressure, and with steam containing 10 per cent. of moisture. The upper limit is found to be about 4,400 feet per second, at a steam pressure of 200 pounds per square inch, at 27.5 inches vacuum, with the steam superheated 200 degrees F.

A certain mathematical relation should exist between the nozzle angle, the velocity of the steam jet, the peripheral velocity of the turbine wheel, and the inlet angle of the buckets. The outlet angle of the buckets should be the smallest possible. Practical considerations limit to a certain degree the attainment of proper angles for the very best efficiency. Thus, in the De Laval turbine, a nozzle angle of 20 degrees has been established for all sizes of the turbine, the inlet and outlet angles of the buckets are made alike, and are 32 degrees for smaller sizes, 36 degrees for larger sizes. With these angles fixed, and taking into consideration the thickness of the buckets, it will be found that the best theoretical peripheral velocity of the turbine wheel will be about 950 feet per second for a steam jet velocity of 2,000 feet per second, and about 2,100 feet per second for a jet velocity of 4,400 feet per second.

Contrary to popular belief, there are no reasons, either theoretical or practical, to prevent the building of a safe turbine wheel, with a peripheral velocity as high as 2,100 feet per second; only economical reasons have put a limit to it. In the turbines that have been built, the actual peripheral velocity varies between about 1,400 feet per second in the larger sizes, and about 500 feet per second in the smaller sizes.

The diameters of the turbine wheels are such, in relation to the given peripheral velocities, that the speeds run from 10,600 revolutions per minute for the largest size, to 30,000 revolutions per minute for the smallest size. These speeds are reduced approximately 10 to 1, by helical gearing, giving driving shaft speeds of 900 to 3,000 revolutions per minute. A single gear wheel is provided in the smaller types, and in the larger sizes they are double.

The high velocities of the rotating parts of the De Laval turbine create some interesting practical problems. The turbine wheel itself is designed with a factor of safety of about 8 at normal speed. A cross section of the wheel would show the disk to increase in thickness from periphery to center, its profile following a curve so proportioned as to produce uniform radial and tangential stresses, due to centrifugal force, throughout the disk. The buckets are inserted into milled slots in the rim of the wheel.

The stresses vary with the square of the speed and with increasing speed they will gradually increase to a point where the wheel will burst. Provision should therefore be made to prevent serious damage in the event of such an accident. In the De Laval turbine this protection is obtained by reducing the thickness of the wheel close to the periphery, which naturally decreases the strength of the wheel at this point, the stresses here being about 50 per cent. higher than in the rest of the wheel. At normal speed the factor of safety at this point of the wheel is about 5; consequently the wheel will burst here at about double its normal speed, and in such a manner that the rim holding the buckets is broken up into pieces, which, on account of their small size, are unable to do any damage to the wheel case. At the moment the rim leaves the wheel, the stresses in the solid wheel body are considerably reduced, at the same time the wheel becomes unbalanced, and as the clearance between the heavy hub of the wheel and the safety bearings in the surrounding wheel casing is very small, the hub of the wheel will come in contact with the latter, which efficiently act as a brake on the wheel, and bring it to a stop in a short time, as with the buckets gone, the steam has no effect whatever on the wheel. Exhaustive experiments have verified these statements, it having been found that turbine wheels without this decrease in section at the outer periphery, having purposely been speeded up, would burst through the center in two or three heavy pieces, which, at the high velocity, a wheel case of ordinary proportions would not resist. Such pieces have been driven through an experimental wheel case of steel castings, having walls 2 inches thick. With the wheels as made, however, they are perfectly safe, and in the event of the rim being stripped, no damage will result except to the wheel itself.

In this connection is an interesting point concerning the speed regulation of the De Laval turbine. In condensing turbines operating with very high vacuum, the passive resistances are sometimes extremely small, and even if the governor valve throttles the steam considerably below the atmospheric pressure, the remaining pressure may be sufficient, at no load, to increase the speed above the normal. To prevent this speed increase, a second regulating mechanism is provided, the purpose of which is to decrease the vacuum in the wheel case. A small valve, operated by the governor, admits air to the wheel case, after the governor has closed the valve in the steam line. This raises the pressure in the wheel case and increases the passive resistances of the wheel, checks the expansion of the steam in the nozzles, and together with the steam throttle valve holds the speed within the normal limits. In case of accident to the governor valve mechanism this air valve will operate, also.

The peripheral velocity of the gear wheels is about 100 feet per second. The pinion is made of high-grade high-carbon crucible or nickel steel. The gear wheels are made of soft steel of low carbon. The teeth are carefully generated at an angle with the shaft center and the pitch is very small, insuring a smooth contact with a minimum amount of noise. The noise cannot be entirely eliminated, but with great care in cutting the teeth, and giving close attention to alignment and center distances, it has been possible to reduce it to a minimum and to a point where it is in most cases of no consequence. The gears are continually lubricated, but with a very small amount of oil. If they get the proper amount of lubrication and care is taken that no sharp grit, such as cement dust, coal dust, or the like, is allowed to enter them, they will operate for many years without visible wear. The gears are encased as much as possible, to prevent the entrance of dust or foreign matter. The gear wheels were originally made of bronze, but it soon developed that this material, as a rule, became crystallized after about two years of continuous operation, when pieces of the teeth were broken off and destroyed the gears. Steel gears have now been in operation for about nine years, without showing any of the disadvantages of bronze.

Little is to be said about the bearings. They are all lined with white metal. The low-speed bearings for the gear shafts are similar to bearings for electrical machinery of same speed, and are provided with ring oilers. Ring oilers, on the other hand, have not proven satisfactory for the high speed bearings. The turbine wheel shaft usually vibrates slightly, which is communicated to the oil rings, they then refuse to follow the shaft, and consequently do not furnish proper lubrication. It is also found that the temperature of the oil in this case will increase too much, and drip lubrication has been found more satisfactory, only a small quantity of oil being required. With the high speed it is very important that the lubrication should not be interrupted, as it takes but a short time for the bearing to run hot. Wick lubrication has so far proven the most reliable. It must, however, be arranged so that the oil leaves the wick tube in drops, and with a sight glass below the tube through which the amount of feed can be ascertained. The oil is filtered by the wick, which insures clean oil in the bearing, and the oil will flow as long as any oil remains in the tank. With oil tanks of ample size there will not be much attendance required. It seems, though, in the present advanced stage, that opposition is sometimes met with in having this method of lubrication used. The common sight-feed lubricator with such a small number of drops as are required, has the disadvantage of a very small opening for the oil, so that a small amount of dirt will suddenly interrupt the lubrication. The bearing will then immediately heat. Any mechanical arrangement for forced lubrication is in itself more or less apt to get out of order.

In the De Laval turbine, like any other radically new machine, there have been practical difficulties to overcome. There have been troubles with bearings becoming overheated. This was partly due to faulty workmanship, but in many cases it can be ascribed to the lubrication, either to failure to keep the oil reservoir filled, or else to sight feed lubricators, which in themselves might cause trouble.

Then there has been trouble with buckets. It has sometimes happened that one or more buckets have broken, and come out of the turbine wheel, but without doing any further damage. Generally the turbine, after losing a bucket, can be continued in operation, as the turbine shaft is sufficiently flexible to take care of the unbalancing, though it is best to take out the turbine wheel and replace the buckets. The only explanation of this trouble is that the buckets are subjected to vibratory strains, due, perhaps, to the turbine wheel not being homogeneous, so that it will, under action of the centrifugal force, expand unevenly in different directions, thereby unbalancing and causing vibration of the wheel at full speed. This trouble has been overcome by replacing the wheel.

The buckets are also subject to more or less wear due to the action of the steam. The cause of this is also very difficult to determine. It may be that the buckets are chemically affected and that thin films of oxide are blown away by the steam, or it may be caused by mechanical wear due to small solid particles coming with the steam, such as rust, or scale from the pipes. It may also be due to some electrical phenomena. However this may be, it is a fact that wear takes place and it is very doubtful that it can be entirely prevented. It has been found in a few cases that buckets have been worn out in a year, necessitating replacement. In other cases the wear has been very slight, even after a run of four to five years. The wear affects only the steam inlet side of the buckets, and will only increase the steam consumption to a slight degree. In tests made on a turbine of 100 horse-power, where the edge of the buckets had been worn away about one-sixteenth inch, the steam consumption was about 5 per cent. higher than with new buckets. The wheel and buckets are, however, so designed that an insertion of a new set of buckets can be easily made at a small cost.

THE PARSONS STEAM TURBINE.

From a Paper by Francis Hodgkinson upon "Some Considerations in Steam Turbine Work," presented at the June, 1904, meeting of the American Society of Mechanical Engineers.

Dr. Stodola, in his excellent work, "Die Damp Turbine," quotes a test by Lewici upon the friction of a 30-horse-power De Laval turbine disk in air and vacuum. The turbine was driven by a calibrated motor, and in order to bring it up to speed, the following power was required:

	Resistance.	
	Atmosphere.	19.6" Vacuum.
Dry saturated steam 3.3 H. P. =	11 per cent.	5 per cent.
Superheat 300 deg. C........	6.25 per cent.	2 per cent.

In view of these facts, it would seem desirable to avoid high steam velocities as much as possible, because of the resulting frictional losses. Another reason is the erosive action of the steam with high velocities. This is quite serious when the steam is initially wet, due to foaming boilers. In this case, matters are generally made worse by the moisture generally carrying with it various kinds of solid impurities.

In this connection, the author lately had some hard drawn Delta metal blades exposed to two steam jets, the one issued from a diverging nozzle with 150 pounds boiler pressure behind it, and the other from a rounded orifice with 1 pound pressure. The size of the outlet of the two nozzles is the same in each case, and the respective velocities were approximately 2,900 and 600 feet per second. The blades were kept continuously exposed to the jets for one hundred and twenty-eight hours, and the erosion was considerable. A rather curious feature is that the erosion was maximum at the center and the extreme edges of the jet.

In turbines other than of the Parsons type, the original impact element has been made use of in simple or compounded form, the pressure fall being secured by nozzles and the velocity abstracted by vanes. Thus each bucket wheel presumably rotates in an atmosphere of uniform pressure at all points. Mr. Parsons, however, early conceived the idea of so designing and locating the turbine vanes that they should perform the functions of bucket and nozzle as well, at the same time confining the steam to the periphery of the wheel in order to avoid superficial friction in large disk areas. The actual construction of this type of turbine is so well known as to require only passing comment. The steam volume progressively increases from inlet to exhaust in an annular space between stator and rotor. The entire expansion, which is approximately adiabatic, is carried out within this annular compartment which essentially corresponds to a simple steam nozzle. There is this difference, however, that whereas in a nozzle the heat energy of the entering steam is expended upon itself in producing high velocities of efflux, in the Parsons turbine the total velocity, due to expansion, is subdivided into a number of steps, in each of which it is reduced through the dynamic relation of jet and vane, so that a comparatively low velocity is maintained from inlet to exhaust; this generally varying from 150 feet per second as a minimum at the high-pressure end to about 600 feet per second as a maximum at the low-pressure end. The action of the steam in this turbine differs from other types also in this respect, that the steam expands in the ring of moving blades, so that a reactive effect is produced in addition to the impulse of the steam as it flows from the guides. The total torque produced at the shaft from the ring of moving blades is, therefore, due to impact of steam from the guides and reaction from the rotating blades. This process is repeated in each element of the turbine, and the average velocity may be maintained at a uniformly low figure throughout. It is evident that here frictional losses, due to high velocities of efflux, are largely reduced.

It has often been held that unless very high vacuum—in fact, an almost uncommercial one—be provided, the economy of the turbine will suffer. This may be so in certain types in which there are idle portions of the bucket wheels rotating in dense mediums. In the parallel-flow type, however, losses from this source are not so much in evidence, by reason of the fact that the steam is confined to the annulus, and the entire circumference is active in producing torque, thus reducing the proportion of friction to useful work.

The question is frequently asked why three diameters of barrel have been generally selected in the Westinghouse-Parsons turbine. This selection has no bearing whatsoever on the design of the machine, but is merely one of mechanical convenience. The proper expansion can be provided for just as well should there be one or several different diameters. It would be found, however, that if a speed and diameter of drum were selected that would permit convenient proportions of blades at the outlet, the blades at the inlet of the turbine would become unmechanically small: similarly, if diameters and speeds were selected to suit the inlet blades, the areas of the blades in the last stages would become unmanageably large. By varying the barrel diameters at several convenient points, corresponding variations may be made in the velocity of the steam, thus permitting blade designs of convenient proportions for both extremes.

It is an important feature of the parallel-flow turbine that the entire annulus between rotor and stator is filled with working steam. It permits the use of large axial clearances between moving and stationary blades without loss in efficiency. In actual practice, this is never less than ⅛ inch, and in large blades it is as much as 1 inch. In all forms of impulse turbine, separation of nozzle and vane results in surface friction of the jet, and particularly an entrainment of the surrounding medium, as in the fashion of a steam injector, thus increasing fluid friction by drawing the steam backward through the idle portion of the wheel.

Although small axial clearances are unnecessary in the Parsons turbine, it is desirable to employ as small radial clearances as possible in order to prevent leakage of steam from stage to stage. In order to avoid over-estimating the probable extent of this leakage, it is necessary to bear in mind a point which is usually lost sight of, and which, in a considerable measure, offsets the loss from this source. In a machine of given size, the radial clearances between the ends of blades and the walls of the turbine would presumably be constant. The greater leakage would, therefore, naturally occur at the high-pressure end of the turbine, or at the beginning of the expansion. By the time the lower stages of the turbine have been reached, the total volume of the steam has become so great, compared with the clearance area, that the latter becomes unimportant. All leakage steam returns energy to the working steam in the form of heat, as its action is similar to wire drawing in a restricted passage; hence it is superheated to a slight degree and serves to partially dry the working steam which contains considerable moisture, due to adiabatic expansion.

In any type of turbine it is necessary to provide glands at the ends of the casings to prevent the escape of steam or the influx of air into the turbine at the point of entry of the shaft. Air leakage is particularly detrimental in cases where it is desirable to maintain high vacuum. Various forms of packing glands have been used, but the later type Westinghouse-Parsons turbines are fitted with an arrangement of water-sealed glands. They require no lubrication, and it is impossible for any oil to escape from the bearings or the lubricating system into the steam spaces. There are no rubbing surfaces in these glands, and it is found that they do not wear out. The water used for sealing them is small in quantity, but it is not necessarily lost, as it may, in a power plant, be taken from the feed-pump delivery and the overflow returned to the feed-pump suction.

On the load being still further increased, an auxiliary or "secondary" valve, commences to open and admits steam as may be required to a later stage in the turbine where the working steam areas are greater, thus increasing in proportion the total power of the turbine. The operation of this poppet valve is the same as the main admission, so that the governor automatically controls the power and speed of the turbine from no load to such overloads as are generally beyond the limits of generating apparatus built on normal ratings.

The intermittent admission of steam to the turbine is productive of some gain in economy at light loads by keeping the temperature range greater than would be possible if the steam were throttled. Another advantage to be derived from this method of admitting steam is that the admission valve and the mechanism that operates it are constantly reciprocating, and consequently get no opportunity to become stuck. The reciprocating motion necessary to operate the mechanism originates with an eccentric driven by the turbine, and is transmitted through the clutch of the governor, causing a continual disturbance; such that the governor is at all times ready to go to a new position with the least change of speed, simply because the "friction of rest" does not have to be overcome.

A turbine has an important advantage: that local temperature conditions vary but little during operation and on steady load are absolutely constant. The reversals of temperature in a reciprocating engine cylinder have no equivalent. Thus the temperature of rotor and stator is at all points approximately equal to that of the steam in the corresponding expansion stages. Generally the stator is made of cast iron and the rotor of steel, so that the differential expansion that must necessarily exist between them has the effect of increasing or decreasing the axial clearances between running blades at different loads. This, however, is unimportant with this type of turbine because of the ample axial clearances provided. The exhaust end of the turbine is bolted to the bedplate, while the steam end is provided with a sliding foot working between machined ways on the bedplate, so as to permit the turbine to expand, as it will. In types of turbines, however, where small axial clearances exist, this question of differential expansion is not such a simple matter.

It has been advanced that the blade construction employed in the Parsons turbine constitutes an element of complexity, which also is conducive to low cost of construction. The author is, perhaps, not conveying new information in stating that the blades are rolled out from special bronze or steel into long strips, then sawed into the proper length, and finally mounted around the periphery of the rotor and the stator in grooves with special separating pieces, the whole being finally calked in position. In practice, it is found that with this construction the blades are never released, except through some special cause, and the construction is of immense advantage in minimizing the delays due to accidents.

In view of the widespread discussion upon the merits of a reheater in reciprocating engine work, it may be of interest to mention the results of its application to steam turbines. The earlier Westinghouse-Parsons turbines of large size were constructed in tandem two-cylinder form, for the purpose not only of reducing the span between bearings, but also to permit the introduction of a receiver between high-pressure and low-pressure cylinders, the arrangement being intended to separate as much moisture as possible resulting from adiabatic expansion, and to superheat the remaining steam. Exhaustive tests have, however, shown the reheater to be of little, if any, value in increasing the economy of the turbine when the high-pressure steam condensed in the reheater coils was charged up against the turbine. An improvement in the separator resulted in an improvement in the operation of the reheater, but, notwithstanding this, no advantage due to the reheater could be observed, and its application does not seem warranted, on account of the decreased compactness of the machine.

In the course of regular operation of power stations, it is not an unusual occurrence that wet steam comes over from the boilers, due to foaming, overfilling, or other causes. The effects upon reciprocating engine machinery need not be commented upon here. In several instances of turbine plants, slugs of water coming over from the boilers have been known to bring the turbine almost to a standstill, but without any apparent damage resulting. As soon as the water passes over to the condenser, the turbine again regains its speed. The effect on the economy of entrained moisture in the steam has been found to increase the steam consumption to an amount about twice the percentage of moisture in the steam, i. e., 2 per cent. of moisture will decrease the economy about 4 per cent.

Finally may be mentioned the system of lubrication desirable with turbine outfits. Essentially a point in mechanical design and independent of the steam cycle, it is nevertheless one on which the successful operation of any machine is absolutely dependent. Although possessing extraordinary features of excellence in the matter of securing great compactness of design, forced lubrication—as ordinarily understood to mean oil under high pressure—does not seem entirely desirable. In the Parsons type of turbine, the projected areas of the journals are proportioned so that the entire weight of the rotating element may be supported upon a fluid film of oil through capillary action alone. A small pump, driven from a worm gear upon the shaft, circulates oil through a closed system, comprising in the order of their arrangement: pump, oil cooler, bearings, and reservoir. The oil is always applied to the bearings at the point of least pressure; that is, it enters at one end and follows a groove along the top of the shell, from which it is distributed around the shaft. The pressure impressed upon the fluid films is due simply to a static head of 1 to 3 feet, sufficient to insure thorough flushing of the bearings. It is probable that the shaft never comes into actual contact with the bearings, but is separated by the oil film. This is evident by the fact that bearings when taken out for inspection after several years' continuous run are found to be subject to practically no wear. In several cases, the original tool marks upon the interior of the shell have been preserved.

The benefits resulting from the employment of a closed oil circulating system and large bearing areas are apparent in the cost of operating a turbine in regular service. As a result of inquiries in several concerns employing Westinghouse-Parsons turbine machinery, it has been elicited that a turbine ordinarily consumes about ¼ gallon of high-grade engine oil per kilowatt capacity per year; or, in other words, the total quantity of oil used per year averages about 100 gallons for a kilowatt turbine. As this oil costs from 25 to 50 cents a gallon, the expense for oil for the turbine is not ordinarily over 7½ to 12½ cents a day, and even this is not all directly chargeable to the turbine, as it is common practice to utilize the oil which is removed from the circulating system on auxiliaries and other low-speed machinery.

It is well known that flexible bearings are employed on Parsons turbines of small sizes in order to permit the rotor to revolve about its gravity instead of its geometric axis, this being necessary at the high speeds employed in order to neutralize the effect of minute errors in the balancing of the disks. The flexible bearings consist of a nest of concentric bronze sleeves with sufficient clearance between them to permit the formation of oil films, which act as cushions, permitting a certain amount of vibration of the shaft, but at the same time restraining such vibration within narrow limits. In the larger sizes of turbines, however, and, in fact, for all machines running below 1,200 revolutions per minute, the flexible bearing is no longer found necessary, and is replaced by a solid split self-aligning journal, lined with anti-friction metal, as in the ordinary forms of low-speed machinery.

* * *

The so-called bronzing process largely used on cast-iron hardware is produced by heating the pieces in the presence of oil, according to a note on the process published in *Modern Machinery*. After the surface is thoroughly cleaned and polished a coat of vegetable oil, say, sweet or olive oil, is applied, and the piece is carefully heated up to almost the igniting point of the oil. At the moment of decomposition the cast-iron will absorb oxygen, and this forms on the surface a brown oxide skin or film, which takes a fast hold and is so hard that it will admit of a high polish, thus bestowing upon the iron a most striking resemblance to bronze.

MAKING MASTER CAMS.

R. E. FLANDERS.

The method of originating master (cylindrical) cams, which is described in the following paragraphs, has been used successfully in a shop where considerable of this work is done.

A development of the cam at the surface of the cylinder is provided by the draftsman. If the cam is smaller than 2½ or 3 inches diameter, or has unusually steep pitches in its make-up, the development had best be laid out for a diameter two or three times larger than that of the desired cam.

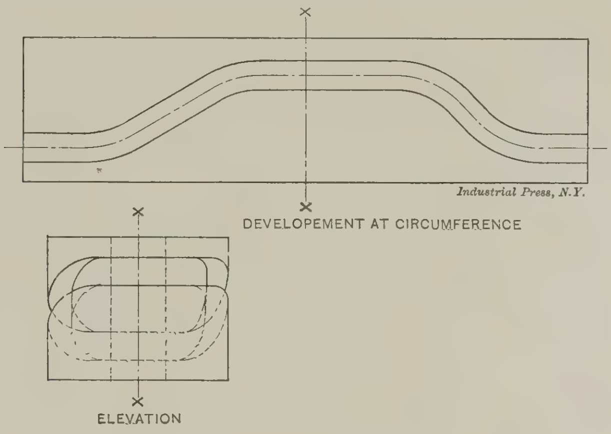


Fig. 1. The Cam and its Development.

Suppose it is desired to make a master for the cam shown in Fig. 1. The first step is to make a template to match the development shown in the drawing. This template may be made of mild steel, of a thickness depending upon the diameter to which it is to be bent, as described later. It may be fitted to the drawing with cold chisel and file, or, if considerable accuracy is desired, in the throw, the template may be held in the milling machine vise, and the straight surfaces finished to the graduations. This template, shown in Fig. 2, is made for one side of the cam groove only.

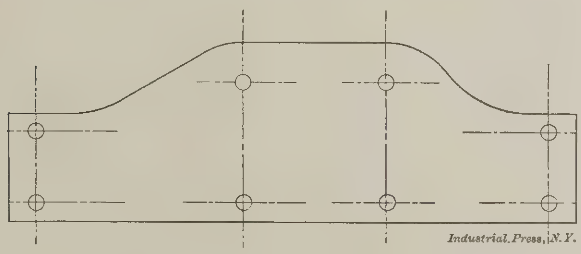


Fig 2. The Template.

The next step is to turn up a piece of steel or cast iron, as shown at *B*, Fig. 3, to such a diameter that when the template *A* is wrapped around it, as shown, the ends will just barely meet. This diameter is about the thickness of the plate less than the diameter to which the development was laid out, but it had best be left a little larger and then fitted. The plate is now clasped around the body, with the back edge pushed close up against the shoulder to insure proper alignment of the working surface of the cam. If any difficulty is experienced in this wrapping process, a circular strap may be bent up with projecting ends as shown in dotted lines at *C*; with the aid of a clamp, *D*, the template may be stretched around smoothly. The template and the body may now be drilled and tapped for screws, as shown, and for dowels as well, if found necessary.

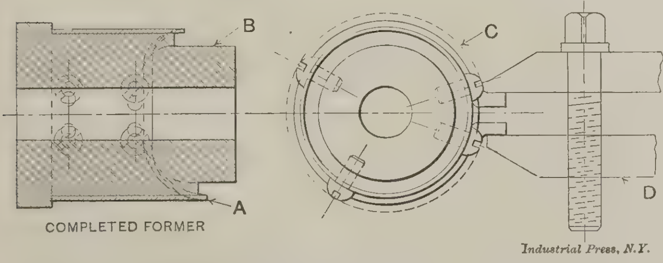


Fig. 3. The Template secured on a Mandrel to make the Former.

Scribe the contour of the cam onto the body *B*, remove the template, place the body on an arbor in the index centers of the milling machine, and take away the stock for about ⅛ inch deep or so for 1-16 back of the scribed line. This, as shown in Fig. 3, is for the purpose of providing a clearance underneath the working edge of the template. The template may now be placed in position on the body once more, and fastened there. The rig is now ready for use as a former for making a master cam.

Fig. 4 shows a milling machine arranged for cam cutting. *E* is a casting made to grip the finished face of the column, and carrying an adjustable block *F*. Cam roll *G* is pivoted on a post which is adjustable in and out in block *F*. Our former *H*, and master cam blank *I*, are mounted, as shown, on an arbor in the index centers. By working the index worm crank, and the longitudinal feed crank together, roll *G* may be made to follow the outline of former *H* in such a fashion that the end mill will cut the desired groove in cam blank *I*. A slightly smaller mill may be used for a roughing cut, but it goes without saying that the roll and the finishing mill must be of about the same size if a true copy of the template is desired. It will be found easier to follow the outline with the roll if the steeper curves are traced down rather than up.

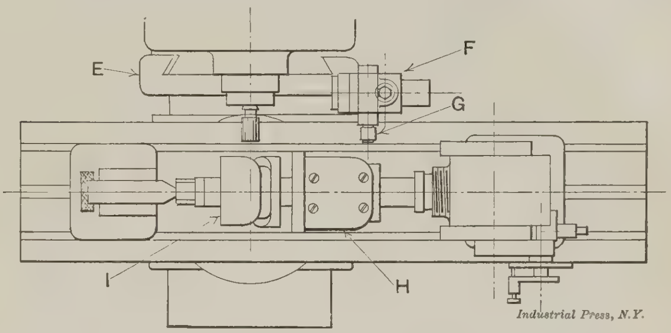


Fig. 4. Set-up of the Milling Machine when using the Former.

A fairly decent cam-cutting machine for making copies of the master cam *I* may be improvised by using the attachment *E*, *F*, *G* in a rack feed machine. It might also be feasible to connect the index worm with the telescopic feed shaft so as to give a power feed to the contrivance. To insure accurate cams, the arrangement for holding the tool must be made stiff enough to move the table without much spring, or the table must be weighted, so as to bring the pressure of the roll constantly against one face of the master cam.

* * *

JIG MAKING.

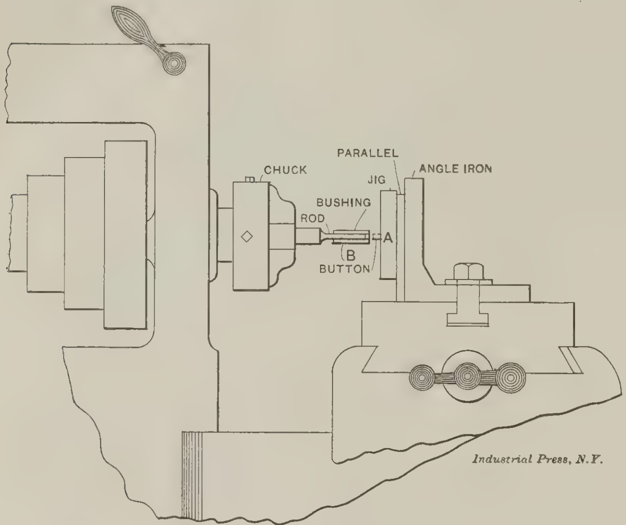
ACCURATELY SPACING THE HOLES.

FRANK E. SHAILOR.

"Interchangeable parts" is a term we frequently hear, but how many parts are "interchangeable" when jigs and tools are made in the old-fashioned way? Jigs are depended upon more than anything else to produce duplicate parts, and unless the greatest care is exercised when making them the term "non-interchangeable" would be more appropriate. The following methods for accurately spacing any work are the best that have come under the writer's notice, and he invites criticisms, for if there are methods more accurate than those herein described, the writer as well as many readers of MACHINERY would be glad to know of them. Before entering upon the description it might be well to say a few words regarding the manner in which jigs are made in different factories. In some factories the jigs are made from a "master plate," described in the May issue of MACHINERY. In other shops the jigs are made from the blueprint, while in others the jig is made directly from a model by transferring the holes, etc. Therefore, in order to produce an *accurate* jig the toolmaker is obliged to employ the method best adapted to the conditions under which he is obliged to work. It has been the writer's experience that the best method for making jigs is by means of the master plate. The next best is by working from the drawing. By so doing the errors that may be in the model (and they frequently occur) are not copied in the jig. The two methods most generally used for accurately spacing the holes are by means of the milling machine and the "button" method.

Unless the milling machine is in excellent condition, being fitted with *corrected screws and dials*, the more accurate method of the two is by means of the "buttons," which will be described later.

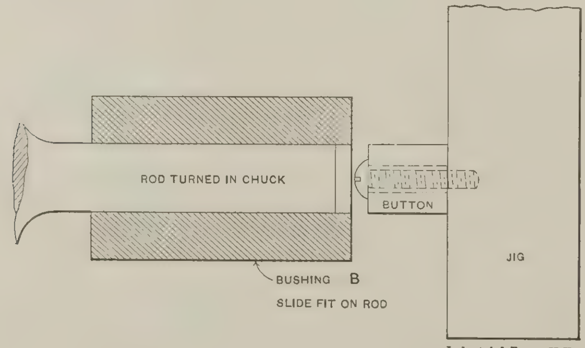
We will first take up the manner in which the jig is spaced on the milling machine. Assuming that the part of jig to contain the holes is machined to exact shape and size, we then proceed to find the center from which the draftsman worked when laying out the holes, and the points where the lines cross is pricked. A hole is now drilled and tapped for a smaller screw, say ⅛ inch—40. A button, Fig. 5, that is hardened, ground, and lapped outside to exact size, say .250 inch, having the ends perfectly square with sides and the hole somewhat larger than the screw is fastened to the jig by means of the ⅛-inch screw.



Industrial Press, N.Y.

Fig. 1. Locating Holes in Jigs with the Milling Machine.

Now with a micrometer depth-gage, verniers, or height-gage, measure from *one* end and *one* side of the jig only to the button. The button is moved until its center is the same distance from the end and side of jig as the distance given on drawing, and is then securely tightened in place. When measuring to the button, one-half of its diameter must, of course, be added to the reading of the instrument used, which gives the distance to the center of button. After fastening the button, its location should be measured again for fear of its having moved when tightening the screw. Having made sure that button is in proper position the next step takes us to the milling machine.



Industrial Press, N.Y.

Fig. 2. The Button, Bushing and Turned Rod.

An angle-plate of suitable size is fastened to the table of the milling machine, and is squared with the machine in every way. The jig to be drilled and bored is then clamped to the angle-plate, being separated from it by parallels, and it is also carefully squared with the machine. The chuck is now placed on the spindle of the machine and a piece of brass, or soft steel rod, is gripped in the chuck and with a lathe tool held in the vise the rod is turned—not filed—to exactly .250 inch diameter, which is the same diameter as the button. A bushing, *B*, Fig. 2, about 1 inch long is next made, having a smooth hole which fits the rod nicely where turned and also fits the button. The vise is removed and the machine is so manipulated that the bushing *B* will slide *without interference* over the button. As the rod was turned in the chuck, it is therefore central with the spindle; so must also be the button on the jig.

When getting the button in alignment all back-lash must be taken up in the screws. For instance should the button on the jig be one or two thousandths of an inch higher than the rod, do not lower the knee until the bushing slips over button, but lower the knee considerably and then *raise* the knee until the bushing slips over the button. The same rule should be followed on the longitudinal movement, namely, should the button be moved a fraction past the rod, the table should be moved back far enough to remove the back-lash and then start forward again. Right here I imagine some reader saying that this is all nonsense, extra work, etc., but I think the majority of readers will agree with me that it is better to devote the two or three hours necessary to take this precaution at the beginning of a job and *know* just exactly where you are starting from and how you will come out at the finish, than to go at a job in a haphazard manner, the starting point, for instance, being a prick-punch mark jabbed into the jig at "about" the center. It saves the worry as to how the jig will test up when finished and the two or three hours (?) devoted to taking off a little here and a little there in order to overcome the errors caused by starting from a prick-punch mark.

To resume: Having made sure that the jig is centrally located on the milling machine knee, relative to the spindles, set all dials at 0 and fasten securely, for when any spacing is done on the milling machine the dials must *not be disturbed after spacing is started.* The rod and chuck are removed and a flat spotting drill, Fig. 3, is inserted in the collet and placed in the spindle. By referring to the drawing the distance given to the hole furthest from the center is noted, and the table is moved exactly the same number of thousandths of an inch. The object in starting from the furthest hole is that the table of the milling machine is thereafter moved in the *same direction* while spotting the remaining holes. Hole No. 1 is spotted and by again referring to the drawing we move the table the given distance and hole No. 2 is spotted, and so on until all holes are spotted.

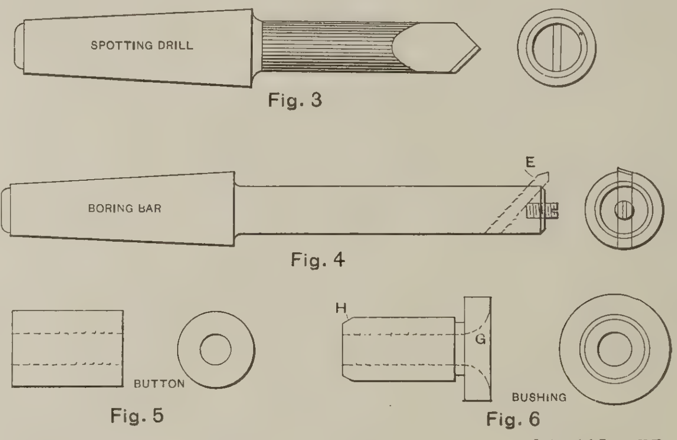


Fig. 3

Fig. 4

Fig. 5

Fig. 6

Industrial Press, N.Y.

Spotting Drill, Boring Bar, etc.

To prove that no error has been made thus far, start from the last hole spotted and work backward to the first hole, removing back-lash each time, and allowing the drill to just touch in the place spotted. If there is an error the lip of the drill will shave the side of place spotted before the center of the drill touches the bottom. Having proved each hole, the spotting drill is removed and a twist drill, which is soldered into a brass taper shank, is substituted. The holes are then drilled, care being exercised not to force the drill, which would tend to displace the jig, and also noting carefully that the drill starts in the spotted places without "springing in." After all holes are drilled, the boring bar, Fig. 4, is substituted for the drill and all holes are bored to within say 0.005 inch of the finish size, which allowance is left for the finish chip. Before taking finish chip the straps holding the jig are loosened sufficiently to relieve all strain or spring there may be in jig caused by drilling and the straps cramping same. The boring bar cutter *E* is sharpened to insure its cutting freely when taking the finish chip, and great care must be exercised not to crowd the bar when cutter is cutting; the bar will easily "spring" and produce an untrue hole. After taking finish chip in the last hole, prove the jig again by starting backward, removing back-lash each time, as before, carefully noting that cutter does not cut in any hole.

The jig is now removed and the bushings, Fig. 6, are next in line. They are made complete on the end of a rod held in the chuck, and the hole is left sufficiently smaller to allow for lapping, and the outside is left 0.01 inch larger to allow for grinding after hardening. The end *G* of the bushing is chamfered considerably and well polished to allow drills to easily enter the hole. The bushing is then cut off from the rod. After hardening the bushings they should be roughly ground *outside* before lapping the hole. The reason is that if the holes are lapped to size the bushing will "change" a trifle when the scale is removed from outside, caused by the internal strains set up during the hardening process. Therefore, it is better to roughly grind the outside first, then lap the hole to size and lastly grind the outside to size concentric with the hole. A very true method for doing this is to turn a piece of steel held in a bench lathe chuck to fit the bushings, and without disturbing chuck or piece, wring on the bushing and then grind outside. The corners *H* should be beveled to prevent the bushing cutting the jig when being forced in. The above described method for spacing holes is applicable only to milling machines having *corrected screws and dials.*

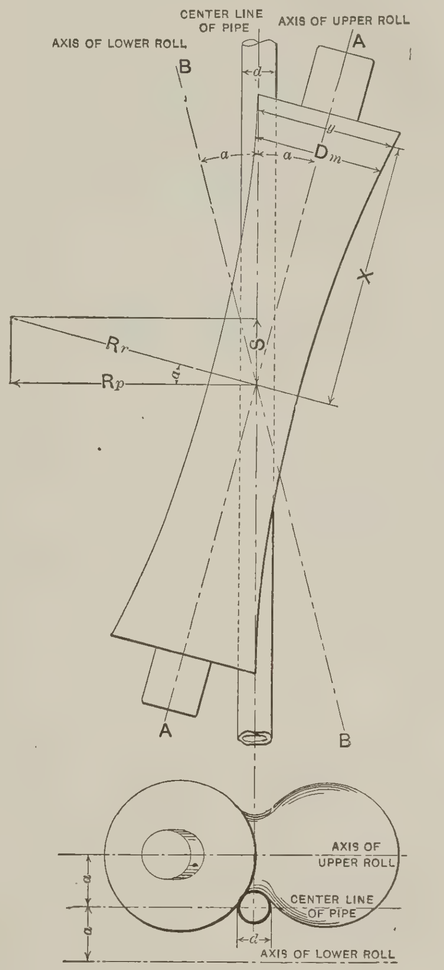
The button method already referred to consists of laying out the location of the holes on jig by means of a micrometer scratch block or height-gage, and where the lines cross a small hole is drilled and tapped. Buttons, like Fig. 5, are then fastened in the proper locations by the same manner already described, namely, measure from one end and one side of jig only to the outside of the button, adding one-half its diameter to the reading on instrument. When one button prevents measuring to next button we then measure from button to button; but it is better to measure from one end and one side of jig to button when possible to do so. Having securely fastened all buttons in their exact relative positions the jig is next fastened to the faceplate of the lathe and an indicator placed on a button. When the jig has been so located that the indicator shows the button to be exactly central with the spindle of lathe, the button is removed and hole drilled and bored. The greatest possible care must be taken when employing the button for spacing work, for there are possible chances of errors creeping in. First the personal error caused by uneven tension on the measuring instrument used, and secondly and greater, the possibility of one or more of the buttons becoming displaced by being unconsciously knocked out of place while working in the lathe.

Another method which is too frequently used for spacing holes, by shops claiming "interchangeability of parts," consists of laying out the jig with a height-gage or micrometer scratch-block and prick-punching where the lines cross. The prick-punch mark is then "wiggled up" in the lathe. But, granting that the lines can be *accurately* scribed on a jig, it does not follow that the point of prick-punch is placed directly where the *lines cross.* And after the prick-punch has been driven into the metal, who can say that the bottom of the prick-punch mark is directly under where the lines cross? This method might properly be said to belong to the "old school" and should be discouraged as far as possible by the rising generation of toolmakers, as at best it is only an attempt at accurate spacing.

* * *

ROLLS FOR STRAIGHTENING PIPE.

In the interesting and valuable paper read by Mr. Victor Beutner before the December meeting of Engineers' Society of Western Pennsylvania on the manufacture of welded pipe, the methods employed for straightening pipe were briefly alluded to. One method employed on the smaller sizes of pipe is to roll it back and forth between large reciprocating plates, very much in the way that our grandmothers straightened knitting needles, that is, by rolling them on the floor with the foot. The best method, however, is said to be that by which the pipe is passed longitudinally between two hyperboloid rolls. This device, shown diagrammatically in the cut, rotates the pipe and pushes it forward at the same time. For clearness in the illustration the lower roll is omitted, it being a duplicate of the upper roll but placed so its axis coincides with the line *B B*. Mr. Beutner makes it appear as though the curve of the rolls is a very complicated affair and he presents a formidable mathematical formula to back the statement up. The principle will be readily understood, however, from the diagram. It will be seen that the greater the angle *a*, the longer is its sine, which corresponds to the longitudinal movement of the pipe through the rolls. The rotary movement of the roll at the middle section is divided into two components, of which *S* is one and *R p* the other.



Rolls for Straightening Pipe.

It is of interest to note that substantially in this manner the velocity of an idler pulley bearing on a broad belt can be varied, that is, by changing its angle of inclination across the belt. When at right angles it runs at the same speed as the belt but when turned from this angle its speed decreases in the ratio of the sine to 1. In other words, when the idler is at an angle of 45 degrees the peripheral speed of the idler will be only 7-10 that of the belt, and so on.

* * *

In making cheap thermometers, says *The Locomotive*, it is generally customary to stamp the scales out in large numbers from sheet metal, and to blow the bulb of the instrument to such a size that the scale will be as nearly as practicable adapted to the finished thermometer. This can be done, by an experienced glass worker, with greater accuracy than might be supposed; but it is evident that no high degree of precision can be realized in this way. The scale and the rest of the thermometer being adapted to each other as nearly as is commercially practicable, the thermometer is then exposed to some known temperature, say 70 degrees, in the vicinity of the temperatures at which it is most likely to be used, and the point on the stem to which the mercury rises is then adjusted so as to be opposite the correct part of the scale. Such a thermometer will give readings that are not greatly in error at temperatures near the one at which it is standardized; but at other temperatures any two such thermometers will necessarily diverge by an amount which depends upon the judgment and skill of the workmen who blew the bulbs.

LETTERS UPON PRACTICAL SUBJECTS.

RE SHAILOR'S MULTIPLYING GAGE.

Editor MACHINERY:

I was much interested in Mr. Shailor's valuable hints on toolmaking in the May issue and, for one, wish to thank him for same. The publication of such articles makes MACHINERY worth many times the subscription price to every progressive mechanic, and I am glad to see the good work go on.

Having thrown my bouquet, I want to register a criticism of the construction of Mr. Shailor's multiplying gages. It seems to me to be a mistake in design to place the retracting spring controlling the pointer so far from its pivot. The pointer is necessarily slender and if the spring is placed quite some distance from the pivot it gives the pointer a chance to bend slightly between the spring and pivot. Of course this deflection is very slight but it will be observed that whatever amount it is, it is in a direction opposite to the movement of the pointer, so that a reading is slightly decreased. I do not want to appear over critical, but it is the observance of these nice points that marks the parting of the ways between good and bad design.

OLD MAN.

FORMULA FOR POWER OF MACHINE TOOLS—TABLE OF LOGARITHMS FOR THIRTY-SECONDS.

Editor MACHINERY:

Having recently had some computations to make regarding the power required for different cuts at different speeds and feeds on machine tools, I found it quite cumbersome on a series of computations, as the formulas are generally given based on the metal removed per hour.

From tests made at the Trigg Works, Richmond, Va., and published in your September, 1902, data sheets, you gave for hard cast iron on a series of experiments $H. P. = .034\ W$, in which W is the weight of metal removed per hour.

As our data comes in the size of feed, cut and the speed in feet per minute, we reduced the above formula to $H. P. = 7\ F\ C\ S$ for an average, in which F = the feed in inches per minute, C = cut in inches, and S = speed in feet per minute.

The feeds and cuts were all in thirty-seconds or sixteenths of an inch, and using logarithms, this required first the looking up of the decimal equivalent, and after finding same, the log. To simplify the calculations we prepared the accompanying table, which gives directly the log. for each thirty-second of an inch. As this table is not found in any hand books, to my knowledge, I think a publication of same would be very beneficial to your readers.

COMMON LOGARITHMS FOR FRACTIONS OF INCH.

$\frac{1}{32}$	$\bar{2}.49485$	$\frac{3}{8}$	$\bar{1}.57403$	$\frac{23}{32}$	$\bar{1}.85658$
$\frac{1}{16}$	$\bar{2}.79588$	$\frac{13}{32}$	$\bar{1}.60879$	$\frac{3}{4}$	1.87506
$\frac{3}{32}$	$\bar{2}.97197$	$\frac{7}{16}$	$\bar{1}.64098$	$\frac{25}{32}$	$\bar{1}.89279$
$\frac{1}{8}$	1.09691	$\frac{15}{32}$	$\bar{1}.67094$	$\frac{13}{16}$	$\bar{1}.90982$
$\frac{5}{32}$	$\bar{1}.19382$	$\frac{1}{2}$	1.69897	$\frac{27}{32}$	$\bar{1}.92621$
$\frac{3}{16}$	1.27300	$\frac{17}{32}$	$\bar{1}.72530$	$\frac{7}{8}$	$\bar{1}.94201$
$\frac{7}{32}$	$\bar{1}.33995$	$\frac{9}{16}$	$\bar{1}.75012$	$\frac{29}{32}$	$\bar{1}.95725$
$\frac{1}{4}$	$\bar{1}.39794$	$\frac{19}{32}$	$\bar{1}.77360$	$\frac{15}{16}$	1.97197
$\frac{9}{32}$	$\bar{1}.44909$	$\frac{5}{8}$	$\bar{1}.79588$	$\frac{31}{32}$	$\bar{1}.98621$
$\frac{5}{16}$	$\bar{1}.49485$	$\frac{21}{32}$	1.81707	1	.00000
$\frac{11}{32}$	$\bar{1}.53624$	$\frac{11}{16}$	$\bar{1}.83727$		

W. F. BRECHT,

Philadelphia, Pa. With Morse, Williams & Co.

CHUCK FOR END MILLS.

Editor MACHINERY:

The halftone, Fig. 1, shows an end-mill holder and two of the mills as well as the cone-nut. A square-end key, not shown, fits a socket in the cone-nut, and is worked through the hole in the hollow spindle. The line cut, Fig. 2, represents a sectional view of the arrangement assembled. In the issue of July, 1902, I described a device similar to this, but considerably smaller; this is in use to-day and works so satisfactorily that we adopted practically the same idea for larger mills, the straight one in Fig. 1 being ¾ inch diameter.

The trouble with these end mills, when using the taper shank form, is that they work out. Whether this is due to the fact that we feed them heavily side-on into cast iron and that part of the time they have no metal in front of the end to prevent their working out, I do not know. Whatever it be, we could not make the taper shank mills do the work, and the device herewith illustrated does the job quicker, better and spoils no work by coming loose.

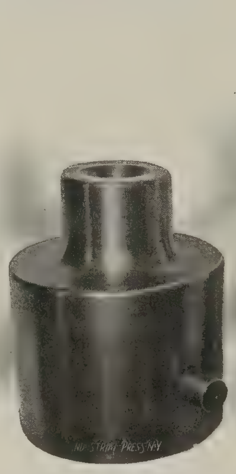


Fig. 1. End Mill Holder, Cone Nut and Mills.

All the parts are tool steel and hardened at the conical surfaces. The nut loosely fits the taper hole in the spindle, and when screwed home on the shank of the end mill with the key through the hollow spindle, holds the mill securely and true by the conical surfaces of the nut, the end mill and the holder.

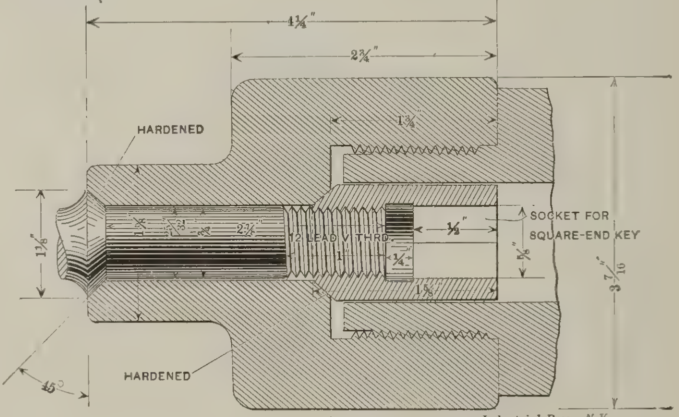


Fig. 2. Longitudinal Section of End-mill Holder.

CORNEIL RIDDERHOF.

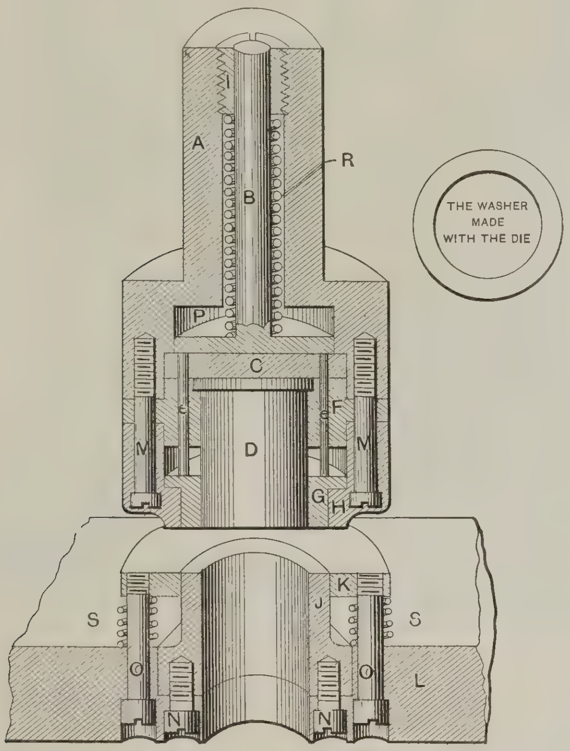
Grand Rapids, Mich.

COMPOUND PUNCH AND DIE FOR LEATHER WASHERS.

Editor MACHINERY:

I send you a sketch of a compound punch and die, for blanking leather washers, for the filler valve on a gasoline stove tank. I am not sending you this because it is anything new, but more for the design, as I have never seen a compound die constructed exactly like it before.

The cut shows the punch and die one-half size. *A*, *B*, *C*, *F*, *G*, *I* and *K* are of machinery steel, while *D*, *H* and *J* are of tool steel, and *L* of cast iron. *A*, which represents the shank of the punch, is bored out large enough to accommodate the spring shown and is held in position by the tension plug *I*, which is bored out so that the shank of the knock-out *B* passes through it and keeps it in alignment with the portion which travels in *P*. It will be noticed by the drawing that the lower portion of *A* is bored a little larger than *P* where *C* fits; *C* acts as a backing for the punch *D*. The piece *C* is made a nice fit into *A*, while *F* acts as the punch holder and is made a nice driving fit into *A* and *H*, and the punch *D* is made a nice fit into *F*. *G*, which is called the knock-out or kicker, is operated by four pins *e*, *e*, etc., which pass through holes drilled in *F* and *C*, and work against *B*. As the punch ascends the spring *R* forces the blank or washer from the punch, and leaves it on the upper face of the die, while *K* strips the stock from the die, and as soon as the punch and die are separated the blank is ready to slide off, if worked in an inclined press; otherwise it must be picked off by hand. *H*, which is the outside cutting die, is held by four ¼-inch fillister screws *M*, and as *H*, *F* and *A* are all snug fits, there is no danger of its shifting. The lower half of the die is made as follows: *L*, which is of cast iron, is made to fit a 4-inch shoe, and is bored out to receive the piece *J*, which is held in place by the four fillister screws *N*; *J* is a snug fit in *L*. The stripper *K* is held in place by the four fillister screws *O*, and operated by four springs *S*.



Industrial Press, N.Y.

Compound Punch and Die for Leather Washers.

It does not seem necessary to give any more instructions in regard to the punch and die, as I believe the drawing shows the construction more plainly than I can describe it, but I might say that I gave no clearance at all, as it was necessary to keep the washers the same size. I thought if I gave it no clearance, there would be no danger of changing the size when grinding, and as the punch does not enter the die over 1-16 inch, it has given excellent satisfaction. I have made several compound dies since, with no clearance, and find they give good results when blanking thin stock, as it does away with the burr, and there is no chance for it to change in size when grinding. While this may be old to some, and no doubt it is, I hope it will be of some help to the younger mechanics who are trying to work their way to the front.

Lorain, Ohio. W. Van Ormand.

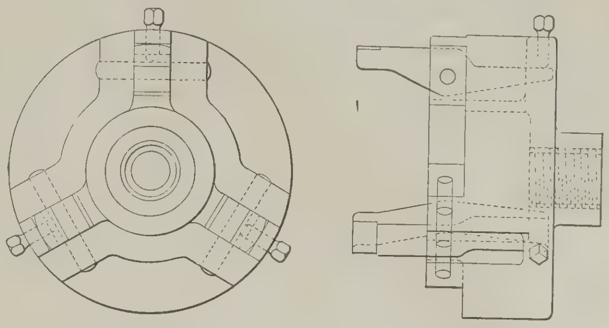
CHUCK AND MILLING FIXTURE FOR GAS ENGINE FLYWHEELS.

Editor Machinery:

I send herewith sketches and description of two fixtures used for machining gas engine flywheels. The fixture shown in Fig. 1 is for holding the wheels for turning, and admits of the rim being finished all over at one setting. The three pivoted jaws of the chuck enter the three cored holes in web of the wheel and when the setscrews are tightened, they hold the wheel with a bull-dog grip, the rim projecting beyond the chuck so that both sides are accessible for turning. The inner end of the hub is faced with an offset boring tool.

Fig. 2 shows a fixture used for milling the angular slot in the rim of the flywheel for the starting handle. Fig. 3 shows the handle inserted in the wheel for use, and Fig. 4 the position of wheel and end mill at the completion of the milling operation.

The wheels are first centered as shown, and a hole the same size as the end mill drilled in the side of the rim on a line passing through the centers and at right angles with the surface. The wheels are then mounted on the centers of the fixture and the end mill inserted in the hole until the collar thereon bears against the surface of the wheel. The spindle having been started, the wheel is slowly tilted to the position shown in Fig. 4. As the wheel is tilted, the spindle carrying the end mill must be raised, the collar on the mill being kept in contact with the surface of the wheel. C. R. S.



Industrial Press, N.Y.

Fig. 1. Chuck with Pivoted Jaws.

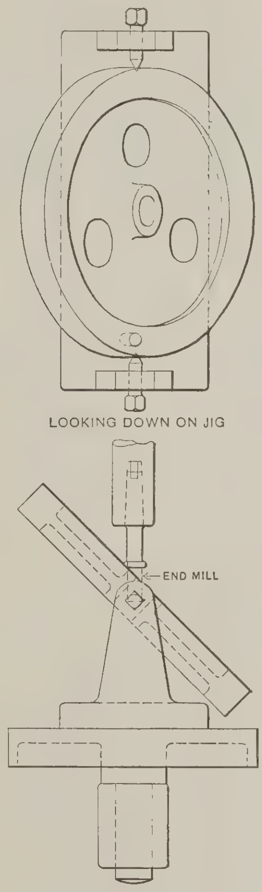


Fig. 2.

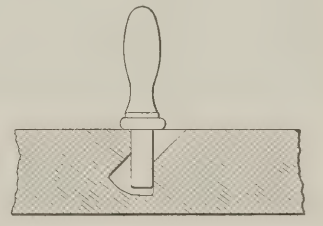
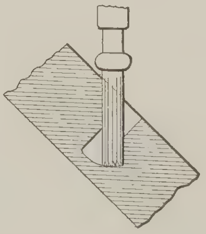


Fig. 3



Industrial Press, N.Y.

Fig. 4.

"WHERE INTERCHANGEABILITY PAYS."

Editor Machinery:

Your editorial on the above subject in April Machinery where you refer to the Russian defenders at Vladivostock being at the mercy of the Japs on account of the shot being a trifle too large for the guns, brings up the point that we would be in the same condition had the champions of the metric system succeeded in forcing its adoption on this government. A hundred-millimeter gun varies just enough from a 4-inch one so no man could tell the difference between the sizes of shot without calipers, and I venture to guess that the trouble with the Russians was not because the guns were not made standard, but because some one has been trying to introduce the metric system, as they have been doing in this country for the last sixty years and where they have succeeded to that extent that our army is blessed with a 75-millimeter gun while all others are in inches. Fortunately perhaps they may not have a 3-inch to make a misfit.

In your reference to the variation in hose couplings, it is not the nozzles that do not fit, but the hose couplings do not fit the hydrants, though that is now being remedied by the adoption of a suggestion made by Mr. W. H. Harris of this city. The cities and villages throughout Central New York are supplying their departments with reducers that fit the hydrants at one end and the neighboring cities' hose at the other. In connection with this there is a little history.

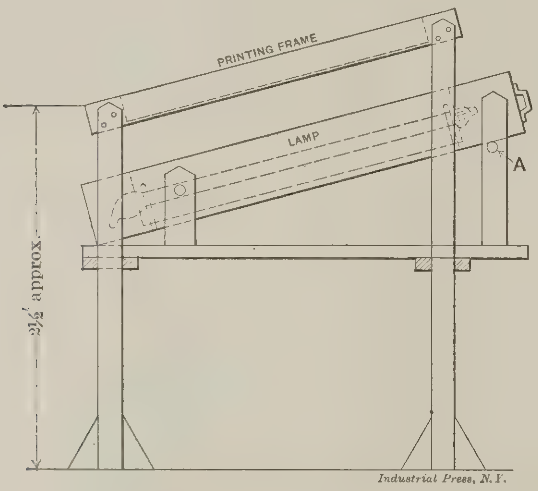
Some ten years ago just after a fire where this trouble gave our fire department a painful experience, the idea of this reducer was given to the president of our Fire Board, who was one of the most enthusiastic fire-fighters, and he failed to see enough in it to do anything toward its adoption. Three or four months ago, following the Rochester fire, the suggestion was made public through one of our daily papers and then in the *Firemen's Journal*, and the scheme is being put in practice, as above indicated, which shows what publicity will do.

Syracuse, N. Y. John E. Sweet.

COOPER HEWITT LAMP FOR BLUEPRINTING.

Editor Machinery:

The photographs shown in the March, 1904, Machinery exposed by the light of the Cooper Hewitt lamp, have already brought to hand enough letters of inquiry regarding the use of the light for photographic and printing purposes to indicate that many are interested in its use. These letters have been of interest to me, and it may be that your readers will be interested in a further notice of the uses of the lamp. The manufacturers of the lamp have as yet put no blueprinting machine upon the market, but the lamp is used in blueprinting as in photographic printing by arranging the printing frame in front of and close to the lamp tube.



Industrial Press, N.Y.

Fig. 1. Blueprinting Frame for Cooper Hewitt Lamp.

A single lamp, when the lamp and frame are stationary, will print a strip about nine inches wide, the whole length of the lamp. If wider prints are to be made either more than one lamp must be provided or the frame and lamp must have a relative motion. Fig. 1 shows a simple method of arranging the blueprinting frame and lamps where they are stationary. For 36 inch x 48 inch prints made in this manner the makers of the lamp advise the use of four of their tilting lamps with nickeloid reflectors. The lamp tubes are arranged to lie about 10 inches from the printing frame glass and prints can be made in one and one-half to two minutes.

If only one lamp was to be used it could easily be provided with a mechanical carrier to traverse it across the space occupied by the printing frame at the proper speed to give good prints. As the greater amount of photographic printing is done in 8 x 10 inch sizes and smaller, to use the full length of the lamp it becomes necessary to provide a frame with suitable openings to hold several of the small printing frames.

Fig. 2 shows such a frame and two lamps arranged as spoken of. In using the lamp to photograph objects with, it is obvious that the shorter the exposure is to be made, the more in number must be the lamps. Where several lamps are used, Fig. 3 shows a common arrangement. In this device each lamp has its individual reflector and each lamp can be run separate from the others in the group. The whole grid or frame can be swung to a position that will light the object being photographed in the best manner possible. By turning on one or several of the lamps, the intensity of the light can be varied at will. Where large machines are being photographed, lamps swung on movable stands are used, in just the same way as white reflectors have always been used to light the darker or more obscure parts. Of course, the light must not be so placed as to shine directly into the lens if good results are expected.

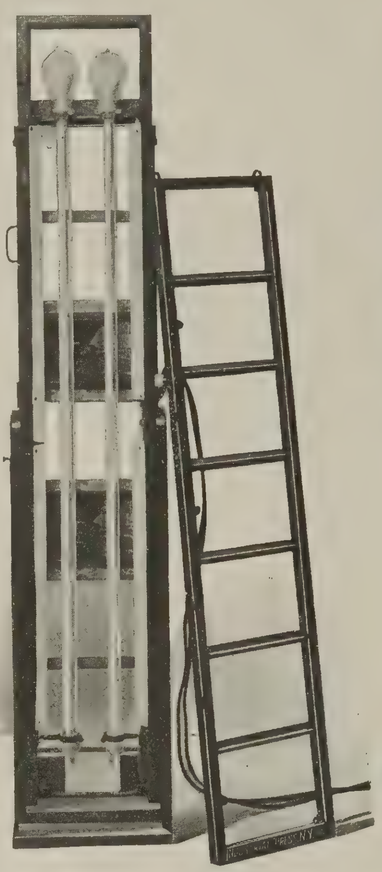


Fig. 2

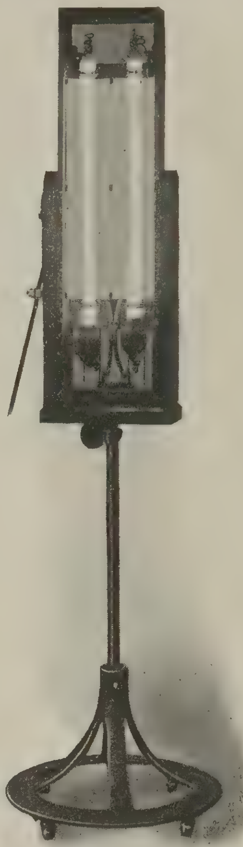


Fig. 4

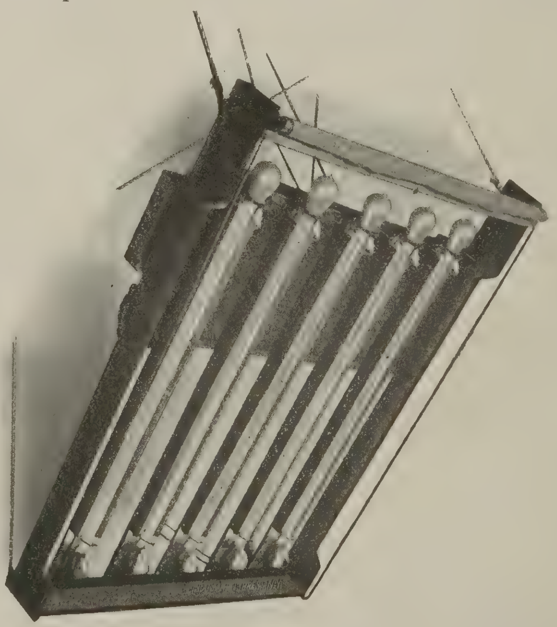


Fig. 3. Frame containing four Lamps as used for Photography.

Fig. 4 shows the lamp as it can be mounted upon a stand when it is desired to use it to light various parts of the machine not lighted by the overhead light. In photographing machines, as in portrait work, a combination of side and overhead light is desirable. H. P. Fairfield.

Worcester, Mass.

[To supplement Mr. Fairfield's letter the Cooper Hewitt

Electric Company have sent us a photograph of the arrangement, shown in Fig. 5, built for the H. H. Franklin Manufacturing Company, Syracuse, N. Y., which uses four V-5 lamps. These lamps have an average life of 1,600 hours and are designed for 100 to 150 volts; two lamps in series may be run on 200 to 300 volts. The Franklin outfit consists, in addition to the lamps, of an ordinary blueprinting frame secured in a stationary position at an angle of about 45 degrees, with the glass side downwards, of course. The lamps are mounted on an independent frame provided with rollers running on short lengths of track. The lamps are tilted for lighting, and then the lamp frame is run underneath the loaded blueprinting frame. It is said that the Franklin Company are much pleased with the outfit; they secure prints in one and one-half to two minutes' exposure.

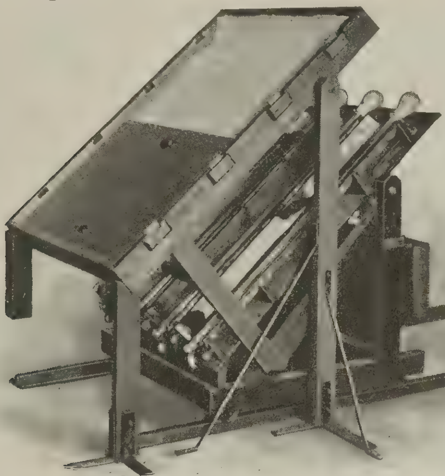


Fig. 5. Blueprinting Frame used by H. H. Franklin Mfg. Co.

While the Cooper Hewitt Company believe that the above is about the best arrangement for blueprinting purposes, using the ordinary frame, they suggest that a possible improvement would be the placing of the blueprinting frame in an almost horizontal position, the inclination being, say, 5 or 10 degrees from the horizontal. The frame could then be more conveniently loaded. The lamps beneath the frame would be lighted by removing the pin *A*, Fig. 1, and lowering the box-holder to allow the mercury to run into the normal upper end of the lamps; raising the holder into position would light the lamps. —EDITOR.]

"THE ETERNAL QUESTION."

Theodore Disch.

Editor MACHINERY:

The article in the April number under the above heading was read with interest by me, and brought back to my mind some of the many experiences in the past thirty-eight years of my shop life. Serving apprenticeship has changed wonderfully in that time, and sometimes I think not for the better for either apprentice or employer.

In those early days the employer took an interest in his employees other than what he could make out of them in the way of money. If he had an apprentice who showed that he wanted to learn and was willing to do his share, his boss took a pride in him and gave him every opportunity to expand, and if in the end he turned out to be a good mechanic his employer was proud of it, and said so. Nowadays his employer hardly knows him, neither does he care as long as the business pays. It is only in the smaller shops that the employer comes in close contact with the apprentice, and then not as close as he used to or ought to, because formerly the employer made it his business to know the boys' families, their circumstances, etc. That is all past now except in rare cases. Formerly schooling was hard to get, and more had to be learned in the shop than now, and he was generally a better mechanic than he is nowadays. He had a better chance to get around the shop to see how things were done and what was being done. Now a boy must stay where he is put. He goes into a shop to serve his time. In the shop they have a routine: First six months on a bolt cutter or cutting-off machine, then on a drill press, then facing nuts or turning bolts, then a shaper or milling machine or some special machine. But the main point is to put him where he can *earn* the most money for the concern. The learning of the trade is a secondary matter with the shop; it must all be in the boy. If he leaves his machine or his work for a few minutes to take note of how this or that is done the foreman calls him down, or if he don't he will get called down himself for not keeping the boy at work.

Mr. Ridderhof says Frank had been working at the trade for eighteen months and did not know how many thirty-seconds there were in an inch. That goes to prove what I say. The people he worked for eighteen months did not care whether he knew anything or not; they kept him at work as long as he was satisfied to earn money for them, and when he got tired of his job he quit or kicked and got fired, as the case may be. I know a great deal depends on the boy, but a whole lot lies in the system.

Formerly men in the machine business were machinists themselves; they were practical machinists. They did not make a fortune at the business in a few years; they felt proud of their trade, but now it is a matter of money—"How much have we made this year? How much can we make next year?" The apprentice must look out for himself. The boss don't care for him. Yes, in some cases, where the boy's parents are acquainted with some of the men in charge of a shop the boy gets a chance or is taken notice of.

I know a case now about two years old. The boy was sixteen and he refused to go to school any longer—thought he knew more than the teachers, and his folks could not induce him to go to school. The father asked me what I thought of him learning the machinist trade. I told him frankly: Let him finish his education, at least in the public school, and he will find it a great advantage in his trade. He will earn from 25 to 50 cents more a day and he will be a better mechanic, etc. Well, I could see that my advice did not take, and the first thing I knew the boy was learning the trade in the biggest shop in the city. In a few days I happened to meet him. He had bought a ten-cent rule which he showed to me. I began asking him questions, and then I found out he did not know how many inches there were in a foot—in fact he knew nothing about the divisions of the rule whatever. Still he was taken on to serve his time, and I questioned him from time to time and I found he never had a clear idea of the name of the tools he worked on or the work he was doing. He was pushed, however. First he ran a drill press, then he faced nuts, then he got a lathe. I tried to find out what he was doing, but he gave me only a vague idea. One time he stayed away from work for several days and I asked him the reason. Well, they gave him some screws to make and they kept jumping out of the lathe and getting bent, so he thought he would lay off until some one else did them and then go back.

This boy was paid more in his first year than most boys get in their third, but he will never be a mechanic. He will be one of the same kind Mr. Ridderhof writes about. But is he entirely to blame? I say no. The firms that take on such help, that pushes them along for what there is in it, that has no better system, that does not care to turn out mechanics, that only wants men to run machines, they are the ones to blame. They don't want men to think; they want to hire some one to do the thinking and some one else to do the work that is thought out.

A man hires out for a machinist helper. He is found capable. Before long he gets a machine to run. He never worked, for nothing or nearly nothing, for several years. He will get 15 cents an hour as helper. He will get 20 or 30 cents to run a machine. He is a machinist just as much as the boy that served four years. He gets as much pay. He does not know how to grind a tool. He does not have to—some one grinds them for him and sets them. In fact, he does not have to know much, only turn out the work and he is all right. He sticks to his job because he knows he cannot get another one very quick. But the fellow that served his time is no better off. He is a lathe hand, big or little, or a big planer hand, or a small planer hand, or a boring mill hand, or any other one thing. But is he a machinist?

Formerly a machinist was a man who could chip and file, run a drill press, lathe or planer. He could work at the vise or on the floor; in fact, he could do anything required of him in the machine shop. He could dress and temper his own chisels, drills and lathe or planer tools. He knew something about pattern work. He knew about blacksmith work, and knew how a casting was made. How many young men that learn the trade learn these things. I think only a small portion. Some I know don't care and others did not have the opportunity.

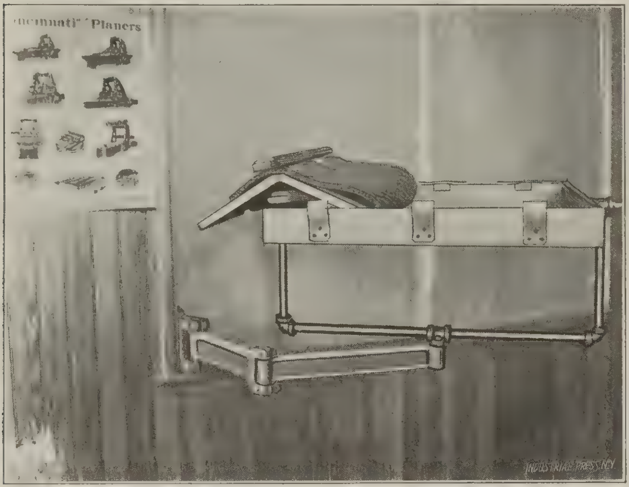


Fig. 1. Blueprinting Frame swung out from Wall.

As Mr. Ridderhof says, it is hard to suggest a remedy, but I think a civil service examination would do a lot of good in the hiring of suitable applicants, and then a desire on the part of the employer to help the boys to become something besides a machine would go a long way toward turning out better mechanics. I believe it would be better for all parties concerned if employers would adopt some system of employing and teaching apprentices. I have had the pleasure in several instances of receiving thanks from apprentices that served under me, after having been journeymen for several years, for what I did for them while serving their time.

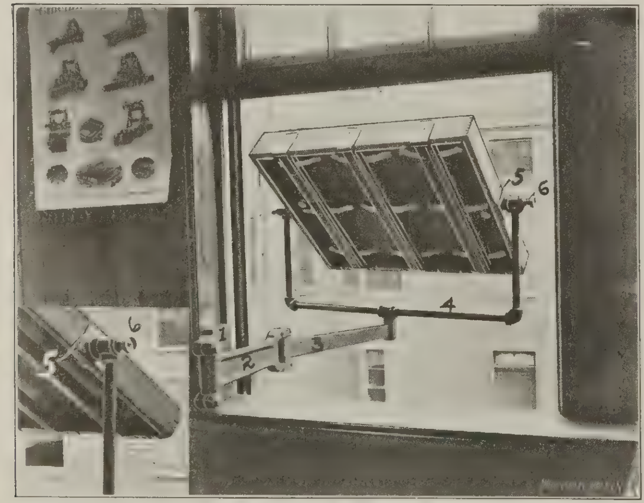


Fig. 2. Blueprinting Frame swung out of Window; also detail of Hinge.

Milwaukee, Wis. THEODORE DISCH.

BLUEPRINTING FRAME.

Editor MACHINERY:

The accompanying halftones, Figs. 1, 2, and 3, illustrate a blueprinting frame, in use at the Cincinnati Planer Co., which is a big improvement over the old style runway that is usually built out of the window on to the roof, or extended out on brackets, and taking up a great deal of space inside of the room when not in use. The frame in the photograph can hardly be called entirely new, as it is merely a combination and improvement over the many similar frames in use in the Cincinnati shops.

Fig. 1 is a view showing this frame swung out from the inner wall with the glass down ready to receive the tracing and blueprint paper. Fig. 2 shows the frame swung out of the window, and shows how easy it can be put in any desired position to suit the light. Fig. 3 shows the frame pushed up against the wall, and illustrates just how little space it occupies when not in use. Fig. 2 shows clearly the various parts required to make this frame, of which 1 is a bracket which is fastened up against the side of the window frame, 2 the first link which extends out from this bracket, 3 the second link, which is put in only to get the universal motion and a longer reach. The part 4 is made entirely of pipe to make it as light as possible, 5 are brass castings, one of which is fastened to each end of the blueprinting frame and 6 are little knurled knobs, which are used to tighten the frame in any position after same is set.

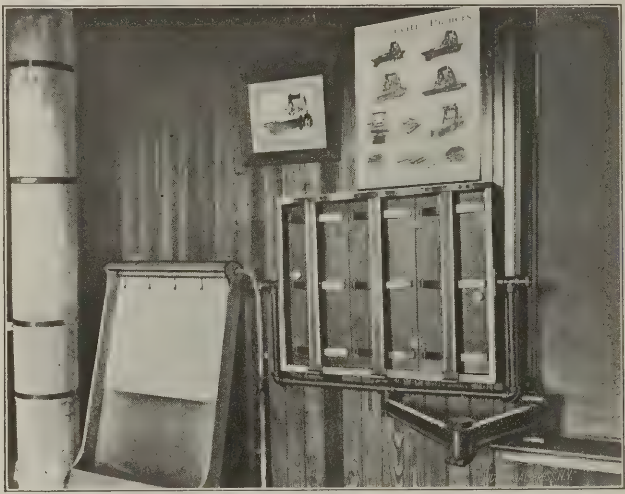
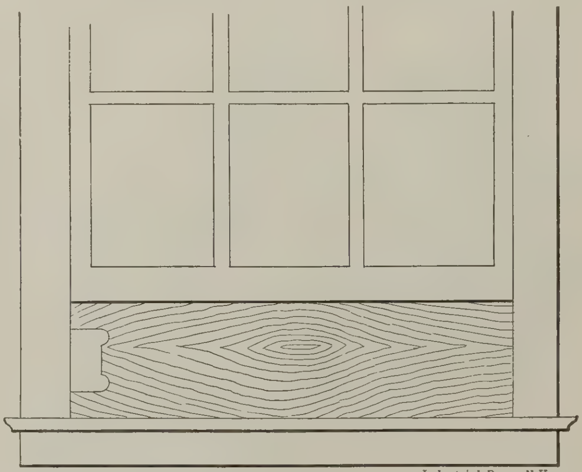


Fig. 3. Frame folded and swung against Wall; also Vertical Washing Tray.

Fig. 3 also shows a wash trough for blueprints, the same as that which was illustrated in the March issue. This is the identical wash trough, in which the so-called "stick-to-itiveness" was developed, but later found faulty when only one blueprint was desired, and for this reason a small rod was put through the top of the frame with several pieces of wire extended down, which can be faintly seen in the photograph. On the outer end of the rod there is a weight attached made out of an old casting, so that when a blueprint is put in position, it is only necessary to raise this weight slightly, put the paper under the wires, and the pressure of the wires will hold same against the stream of water.



Industrial Press, N.Y.

Fig. 4. Board for closing Window Aperture when Frame is in use.

In the extreme left of Fig. 3 can be seen a large pipe, which is our exhaust pipe; this passes through the drawing room on its way to the roof. By putting a few rubber bands around the asbestos covering to hold the tracings, it forms a rapid drying apparatus after the prints are washed.

In cold weather a board, as shown in Fig. 4, is put under the window to keep out the cold.

Hartwell, O. WM. ZINSMEISTER, JR.

DECIMAL THREADS AGAIN.

Editor MACHINERY:

The article on "Decimal Threads," by Mr. Fred H. Colvin, in the April number of MACHINERY, was read with interest. His method is, however, open to criticism, as he does not get exact results, when he could do so just as well as not. If you will allow me the space I would like to show you how I get at these fractional and decimal thread examples, and for the benefit of those who may be a little rusty on fractions and ratio, perhaps it would be well to state a few facts or rules concerning these subjects, which we used to study in school:

Multiplying or dividing both terms of a fraction by the same number does not change the value of a fraction. The relation of one number to another of the same kind is, ratio.

When the relation of one number to another is sought, the first number is the dividend, and the second the divisor.

When the relation between two numbers is sought, either may be considered as dividend or divisor.

The numbers compared are called the terms of the ratio.

The sign of ratio is the same as that of division without the dividing line, and it means the same.

Now we know that division may be indicated by placing the dividend over the divisor in the form of a fraction, and ratio can be indicated in the same way, by placing the first term over the second in the fractional form. Thus, the ratio of 12 to 8 can be indicated 12:8 or 12-8, and according to the first rule 12-8 = 3-2 (dividing both terms by the same number, 4), and we know that when we multiply one fraction by another we multiply the numerators together for new numerators and the denominators for new denominators, hence the fraction 12-8 might be considered as the product of 3-4 × 4-2, or 4-4 × 3-2, etc., or it might be expressed in the form of $\frac{4 \times 3}{2 \times 4}$. This juggling should be remembered when compounding gears.

Mr. Colvin explained very satisfactorily in his November article how to find the lead of the screw of the lathe, or its equivalent lead, so I will not go over that ground again.

It always seems to me that the best way to show any one how to do anything of this kind is to give examples and work them out, and explain as we go along. In the examples given the lathe will be considered as though when gears of the same size are placed on the stud and screw, that the thread cut will be the same pitch as the lead screw of the lathe. In the case of a decimal thread the ratio of the lead to be cut to the lead of the lead screw is the same as the ratio of the driving gear or gears to the driven gear or gears.

Let us consider Mr. Colvin's first example. A thread to be cut with a lead of .40 and a lead screw with a lead of .20. As there are the same number of decimal places in each number we will drop the decimal point and consider the numbers as whole numbers and expressing them in the form of a ratio, we have 40:20 or 40-20, which means the same thing. Now as we said before, this ratio of the leads of the screws is the same as the ratio of the gears, and if we had a gear of 40 teeth and one of 20 teeth we could put the 40 on the stud and the 20 on the screw and go on and cut our thread.

If we do not happen to have one of these gears the best thing to do is to reduce the fraction 40-20 to its lowest terms, which is done by dividing both numerator and denominator by the same number, 20. Then, we have 2-1, and now all we have to do is to multiply the 2 and the 1 by some number so as to get gears that we have at hand.

Now we will take the example where Mr. Colvin had a lead of .15 inch to cut, and the lathe had a lead screw of 6 threads per inch, or 1-6 inch pitch. Mr. Colvin stated that it would be impossible to cut this lead exactly on an ordinary lathe, but it is possible, and it is just as easy as it is to cut any other lead. Instead of stating the ratio .150 : 166 + which is not exact, it should be stated 15-100 : 1-6. Now, as before stated, the sign of ratio means the same as the sign of division and dividing 15-100 by 1-6 we get 90-100, which is the exact ratio of the leads of the screws or of the gears, and if we had gears of 90 and 100 teeth we could put the 90 on the stud and the 100 on the screw and cut our .15 lead exactly. If we have not these gears reduce the fraction 90-100 to its lowest terms in the same manner as before, and we get 9-10, and multiplying both terms of the fraction by 4 we get 36-40. These are very common gears; or we might multiply by 6 and get 54-60, which are usually found at hand. So you see there is no use of getting scared at a 6-threads-per-inch lead screw.

I once ran a lathe with a lead screw of seven threads per inch. Now 1-7 expressed as a decimal is .142857+, which looks rather unpromising, does it not? But if we proceed as before and was to have that same .15 lead to cut it would be just as easy. Thus, 15-100 : 1-7, or 15-100 ÷ 1-7 = 105-100 =21-20, which is the ratio of the gears, and multiplying both terms by 2 we get 42-40, which are very common gears. Now if the lead to be cut should be given in thousandths, we would go at it in just the same way. For instance, if the lead should be .125 call is 125-1000 and proceed as before, and in so doing you get exact results.

Now let us consider the last example in Mr. Colvin's article. It seems to me that he goes to unnecessary trouble. Example—Lead screw 6 to the inch; thread to be cut ⅜ inch lead. Solving as before ⅜ : 1-6 or ⅜ ÷ 1-6 = 18-8 = 9-4, and multiplying the 9 and 4 by 6 we get 54-24, or multiplying by 8 we get 72-32, or we might use several other combinations. There is no necessity of reducing the fractions 1-6 and ⅜ to the same common denominator, as it is a waste of time.

Now let us briefly take up the subject of compounding gears. Referring to the fore part of the article where we spoke of juggling fractions. In the same manner as we factored the 12-8, that is, divided it up into the two fractions ¾ × 4-2, etc., we will factor the 90-100 in Mr. Colvin's example where he had a lead of .15 to cut and the lathe had a lead screw of 6 threads per inch. Thus, $\frac{90}{100} = \frac{10 \times 9}{5 \times 20}$, or $\frac{10}{5} \times \frac{9}{20}$ and multiplying the 10 and the 5 by 6 we have 60-30 and multiplying the 9 and the 20 by 4 we get 36-80. Now the 60 and the 36 are the driving gears and the 30 and 80 are the driven gears, and Mr. Colvin stated in his November article how these gears should be placed on the lathe. Of course we might have multiplied the two fractions 9-20 and 10-5 by any numbers so as to get gears that we have at hand.

Syracuse, N. Y. GEO. G. PORTER.

Editor MACHINERY:

I have read with interest Mr. Colvin's article about gearing the lathe for cutting decimal threads in the April number, and would suggest a way of transforming the decimal to a fraction as a matter of convenience and accuracy when a 6-pitch lead screw is to be dealt with, as the decimal in such cases is really dangerous, as the following comparison shows:

The .15-inch lead thread is a 6 2-3 pitch, found by dividing 1.00 inch by the decimal .15, or 1.00 ÷ .15 = 6 2-3. As our lead screw is 6, we have 6 and 6 2-3 for proportional numbers. By multiplying both these numbers by 9 we get 6 × 9 = 54, and 6 2-3, × 9 = 60. We have 54 for the stud gear and 60 for the lead screw gear, which are numbers that are likely to be found with a lathe having a 6-pitch lead screw; if not, multiply by some other number that will produce numbers matching the gears in stock.

To prove: The pitch of the lead screw 6× 60 = 360 ÷ 54 = 6 2-3 the desired pitch. Now taking the approximate gears found by the decimal system we have the lead screw 6 × 44 = 264 ÷ 40 = 6 3-5, which is an error in one inch of 6 2-3 — 6 3-5 = 1-15 of one thread.

In the last example the ratio number of 2.23 must be a mistake, as it figures out to 2.25+. However in this case by dropping the balance of the decimal this figures out the same as the rule given above. But how are we to know just how much to drop or add, and isn't this decimal rule likely to get us into trouble? M. H. BALL.

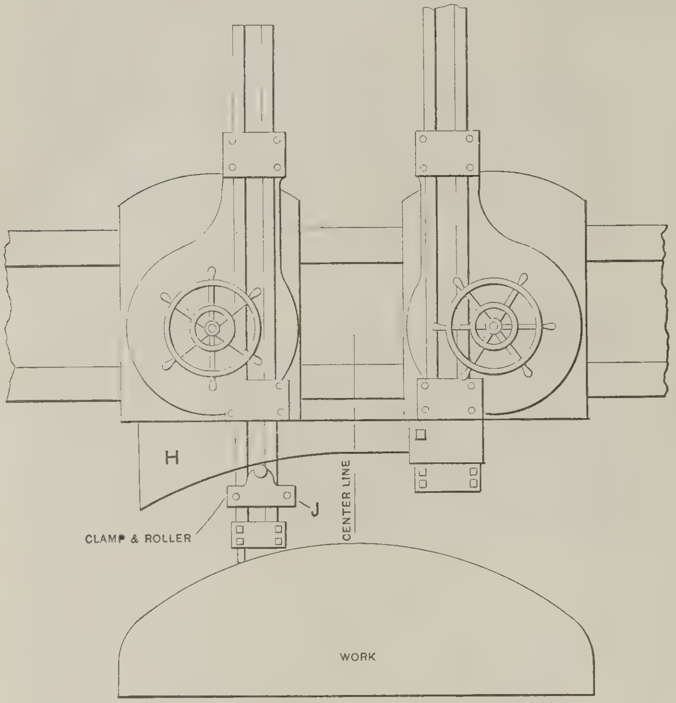
BORING MILL ATTACHMENT—PATTERNMAKERS' TOOL FOR BORING SPHERICAL SEATS, ETC.

Editor MACHINERY:

In the February number of MACHINERY I find described a boring mill attachment for boring spherical seats which recalls a device that I saw used for turning large convex surfaces.

These were in the neighborhood of five feet in diameter, and the radius of the surface was about equal to their diameters.

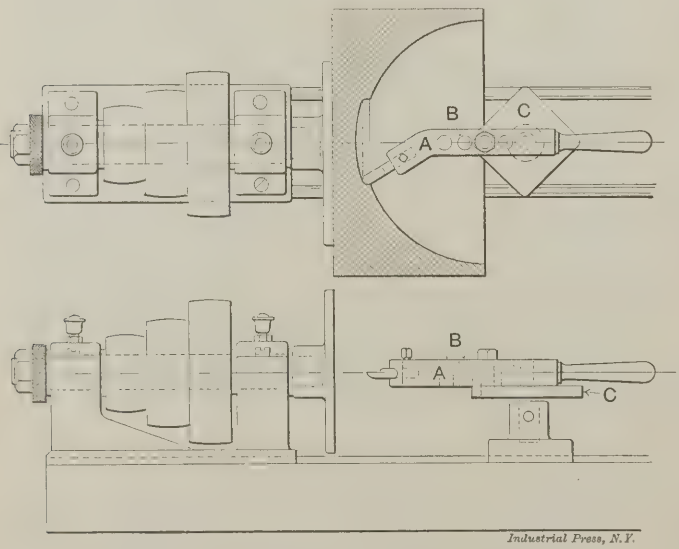
A template, marked *H* in Fig. 1, was securely fastened in the toolpost of one of the heads, and this bar was locked in position. Upon the other bar was fitted a clamp *J* carrying a stud with roller designed to bear against the curved edge of the template *H*. The work having been clamped in position so that the center coincided with the center line on the template the free bar carrying the cutting tool was fed down and the cut started at the center of the work. The clamp *J* was then moved until the roller bore against the template then secured by its bolts, and the crossfeed put on. The cut shows the tool at about the middle of its travel. This device was used under the direction of Mr. Geo. Klages, Superintendent of the Specialty Manufacturing Co., of Allegheny, Pa.



Industrial Press, N.Y.

Fig. 1. Boring Mill Attachment for Turning Convex Surfaces.

Some years ago I was in charge of a pattern shop whose specialty was fittings. Occasionally we made patterns for globe valves of from four to eight inches diameter, and to turn the spherical part of the core box I devised a special tool holder, which is shown in Fig. 2. The holder proper, *A*, is made from 1¼-inch square iron. In one end is a ½-inch reamed hole in which the cutting tools made from drill rod ground to shape and hardened are held, being secured in place by a ⅝-inch setscrew, and back of this are drilled a number of holes *B* to provide for the different sizes to be turned. *C* is a cast iron plate similar in shape to a plasterer's hod, the handle part being made to fit in the hole of the lathe hand rest base. Near one corner of the square plate a hole is drilled to receive the stud that forms the fulcrum upon which the bar swings. The bar is bent near the end at an angle of 20 or 30 degrees so that the tool may swing through the required 90 degrees without the bar coming in contact with the work at the back of the lathe. On account of the offset of the tool the bar must be held closely pressed to the surface of the plate, and it would doubtless be improved by providing a bridge or cleat to prevent the bar from tilting. In setting up it is of course necessary to have the cutting edge of the tool at the same height as the center of the work and the fulcrum center in line with the lathe centers.

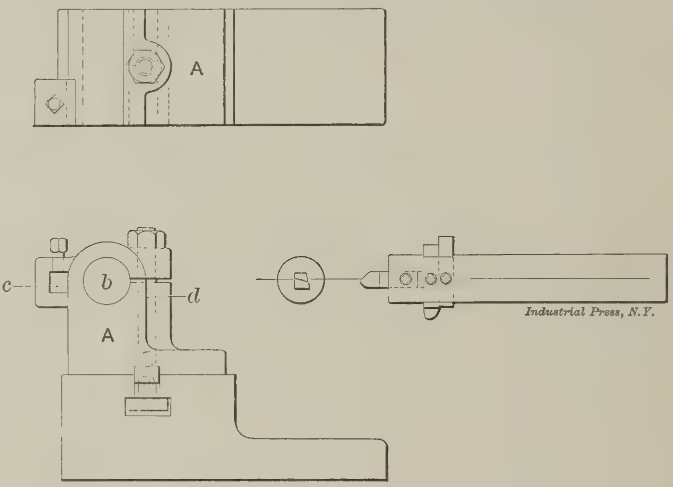


Industrial Press, N.Y.

Fig. 2. Patternmakers' Tool for Boring Spherical Seats.

Being on the subject of lathe bar tool holders I will describe one that I made for a 20-inch Lodge & Shipley lathe and which proved a very serviceable fixture. Referring to Fig. 3 *A* is a casting bored at *b* to take a 2-inch round bar, and which also has through the projecting lug a ¾-inch square hole *c*. In the bottom of the casting *A* is planed a groove the same width as that in the compound rest. In this groove is fitted a tongue of machinery steel which is fastened to the casting by two flat head machine screws. I make this tongue removable because on several occasions I found it in the way. A ¾-inch square head bolt *d* serves the double purpose of clamping the round bar and securing the block to the rest. I also made bushings so as to use 1½ and 1 inch bars. The ¾-inch square hole provides for an extra cutting tool, which was generally used for facing and often saved the time of changing tools.

On one occasion I used this holder, as shown in the cut, with a 2-inch round bar carrying three tools; one in front for facing, one for roughing and one for finishing the bore, which was 3 inches in diameter by 2½ inches long. About fifty of these pieces were machined with this rig, which in combination with the feed-changing feature of the lathe produced a result that was an eye-opener to quite a number of men, the average time required being about one-third of their estimates, which were based on old-style methods and tools.



Industrial Press, N.Y.

Fig. 3. Compound Boring Bar.

The first operation was to face with the end tool, one cut being sufficient. The front tool was then used for roughing out the bore, working by a line on the cross feed. The second cutter was for finishing, and using the micrometer reading on the cross-feed screw the pieces were rapidly brought to accurate size.

I have heard many men claim that the greatest advantage of the modern lathe is in the quick changes that may be made for chasing, but while that is a very useful feature, I think that the many changes of feed that are at hand for instant use are still more valuable.

When a workman begins a job of turning or boring he starts a cut using the judgment born of experience as to the proper speed, depth of cut and feed. Naturally he endeavors to avoid overloading his lathe, but if he is a good man he can tell whether it will stand more feed, and he adds little by little until he finds the limit, settles just below, and has the satisfaction of knowing that this particular job cannot be done much quicker.

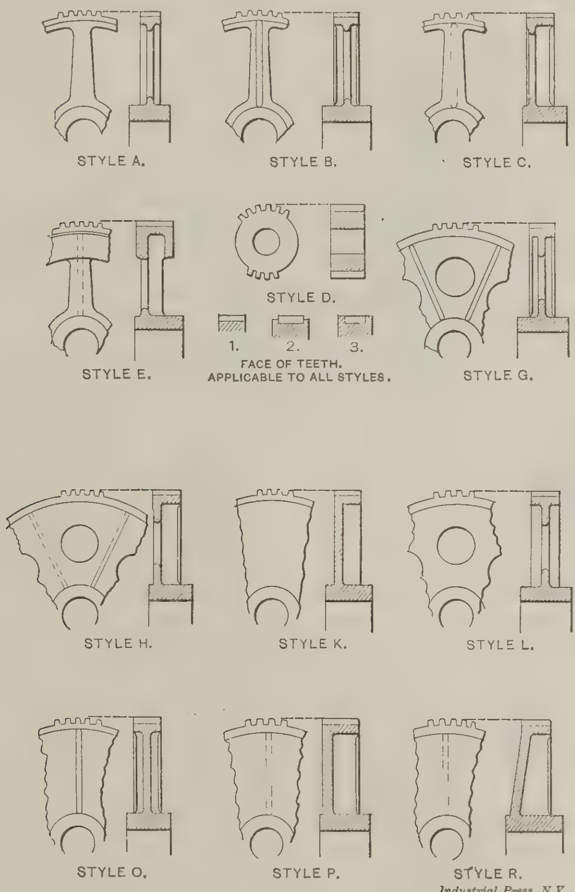
I always like to know the limit the machine will stand, though if the job is a short one it may be best to finish it on your first judgment. If, however, it runs to a half-hour or more, I think it pays to experiment. I remember starting one time to find the limit on rough-turning some soft steel shafts. Formerly they had taken from ten to twelve hours. I spent three days on the job and the average time for each was two and one-half hours, some few being done in two hours and ten minutes. All of which goes to show what can be accomplished by keeping everlastingly at it. A. MERTES.

Emsworth, Pa.

SYSTEM FOR KEEPING TRACK OF GEARS IN DRAWING ROOM.

Editor MACHINERY:

Where there is a considerable variety of spur gears used in the construction of the various machines in a shop the following method of keeping account of them is a time-saver, especially in the drawing room, as it enables the designer to see at a glance just what gears there are patterns for, without going through the various drawings.


STYLE A. STYLE B. STYLE C. STYLE E. STYLE D. STYLE G. STYLE H. STYLE K. STYLE L. STYLE O. STYLE P. STYLE R.

Industrial Press, N. Y.

System for Keeping Track of Gears in Drawing Room.

The method proposed is to make up a table showing the gears which run together in pairs, and if sketches are made and the various styles designated by letters and numbers, it will be found of convenience. Thus style A has arms in the center of the rim, style B is similar but has ribs to strengthen the arm, and style G has a web or plate with openings and is ribbed. The openings beside reducing the weight are of convenience for purposes of clamping or for inserting drivers when turning. Details 1, 2 and 3 show whether the teeth are unshrouded, shrouded to the pitch line or shrouded to the full depth of tooth. The table shows a gear and pinion, the pinion being shrouded to the pitch line, as shown.

SPUR GEARING.

No, Teeth.	P D	C P.	D P.	Face.	Form.	Style.	Weight.	Dr. No.	Remarks.
60	30″	1.57″	2.	3½″	Involute.	C—1	370 lbs.	..	Machine cut pattern
12	6″	"	"	"	"	D—2	26 "	..	" " "

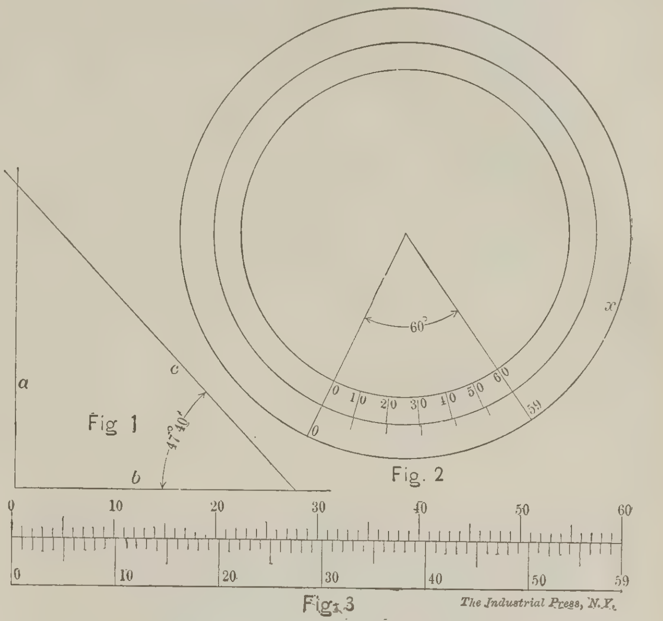
P D stands for pitch diameter; *C P*, circular pitch; *D P*, diametral pitch; *C*—1, style C unshrouded; *D*—2, shrouded to the pitch line. It is of advantage to show the gears which run together in pairs as then the ratio can be conveniently used when calculating for power or speed.

East Providence, R. I. JOHN T. GIDDINGS.

WORKING TO MINUTES WITH A PROTRACTOR.

Editor MACHINERY:

Occasionally one has to work angles down to minutes. There are several ways to do it. One is to lay out the angle on a flat plate, one edge of which is straight, using a table of natural trigonometrical functions to find the dimensions. For instance, lay out the angle 47 deg., 40 min. Take any length for base line, say 5 inches. Find the tangent of angle 47 deg. 40 min $= \frac{a}{b}$, or 1.0977. Therefore $a = 5.4885$ inches.



The Industrial Press, N.Y.

Lay out line *a* with a square and vernier and scratch a line with a needle stuck in an old penholder. Scratch line *c*, and set the protractor blade to it.

Another way without the aid of trigonometry, is to mark on the outside ring of a protractor, using a milling machine and index-head a division equal to 60 degrees, but instead of dividing it into 60 divisions, like the inside ring, divide it into 59 divisions. Fig. 3 represents it more clearly. The divisions on the lower part are practically 1 minute longer than those of the upper part.

To move the lower part 40 minutes to the right, count 40 divisions on the lower line from the right-hand end and make that division line up with the one marked 20 on the upper row.

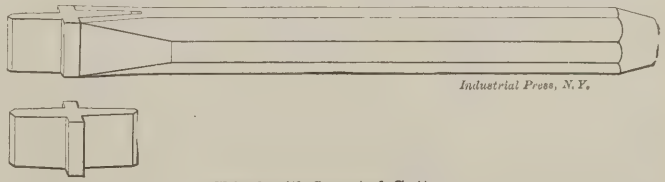
The chief difficulty in this method is the marking and indexing of the 59 divisions, but once it is done it will last a life time. C. W. SHELLY.

New Britain, Conn.

[This, of course, makes a vernier or the usual means employed on instruments for getting small divisions of circular or linear measure.—EDITOR.]

CHISEL WITH INSERTED CUTTER.

We, who are in the machine business, have become pretty well acquainted with inserted lathe and planer tools during the past few years, and everyone knowing them must acknowledge that their use is economical of steel and tool-dressing. But an inserted cutter chisel is another matter and it would scarcely be regarded as a practical device without good proof to the contrary. However, a British concern called the Patent Stone-Dressing Tool Co., of Sheffield, are making the chisel shown in the cut for engineers, iron founders, etc., which requires no forging, and which is claimed to be a practical substitute for the regular tool that has to be taken periodically to the tool-dresser.


Industrial Press, N. Y.

Chisel with Inserted Cutter.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

RUSTLESS SOLDERING SOLUTION.

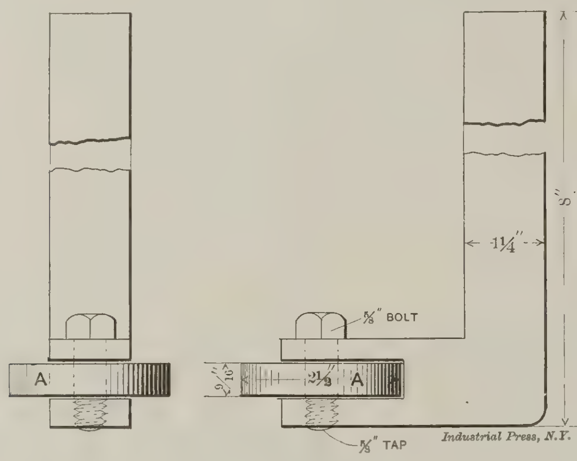
In reply to C. W. B.'s inquiry for a rustless soldering solution I would recommend liquid rosin. It is made by simply adding enough grain alcohol to dissolve the rosin. We use this solution for soldering wire as small as 0.001 inch diameter. It contains no acid that would tend to cause rust. Keep in a bottle well corked to prevent the alcohol from evaporating.

Frank E. Shailor.

Great Barrington, Mass.

TOOL FOR CENTERING WORK ON BORING MILL TABLES

The little tool shown herewith is a handy device for centering boring mill jobs. Suppose, for instance, that it is desired to center up a large heavy ring so as to take a cut off the face, or to center any large heavy piece that is of circular shape. Ordinarily the operator has to take something heavy and bump the job around on the table until he gets it running true, but with this simple tool clamped in the tool holder and held against the work (on the inside or outside) with the table running, the job can be centered in a very short time. Care must be taken, however, not to push the work on the table too far and to have the wheel *A* in the tool run true.



Industrial Press, N.Y.

Monessen, Pa. Earl G. Arnold.

METHOD FOR CLAMPING CONTROLLER RINGS FOR FIRST SAW CUT.

These rings were received from the lathe turned, bored and faced, and were then to be cut into various sized segments with thin saws. This part of the work was done on the milling machines, being held in special fixtures, but the rings required an initial cut to receive an index pin in the fixture. For making this initial cut in many rings at one setting I devised the fixture shown below:

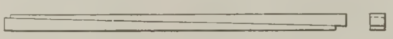


Fig. 3

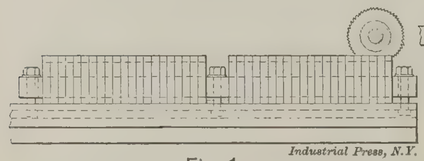

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Fig. 1

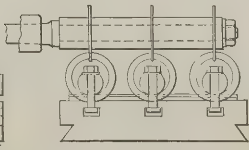


Fig. 2

Fig. 1 shows a side and Fig. 2 an end view of the device, while Fig. 3 illustrates the arrangement of wedges for raising the bars to facilitate putting on or removing the rings. As many bars can be used as there are slots in the table of the milling machine. The bars should be as large as possible and allow the saws to clear the bolts. The bolts at the center of the bars pass through holes but at the ends of the bars slots are used instead, so the bolts may be quickly moved away when the rings are to be put on or removed.

R. A. Lachman.

Chicago, Ill.

CHEAP MILLING CUTTERS FOR EXPERIMENTAL WORK.

Those who are engaged on model or experimental work are often called upon to make small gears and pinions of special-shaped teeth. The accompanying sketches show two styles of cutters that are well adapted for temporary use and are quickly made. The cutter shown in Fig. 1 is made same as any gear cutter with the exception of backing off for clearance. After the teeth are cut the slots *A* are sawed back of the teeth and the clearance for the cutting points is obtained by setting the teeth back as at *B*, thereby doing away with the slow process of backing off each tooth.

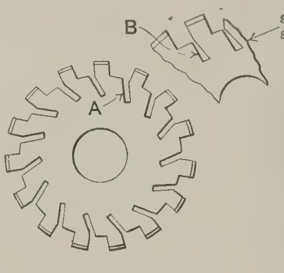
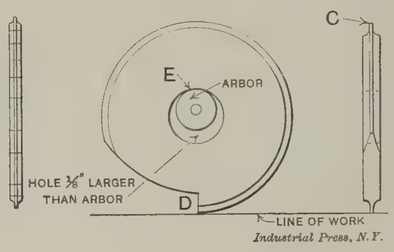


Fig. 1.



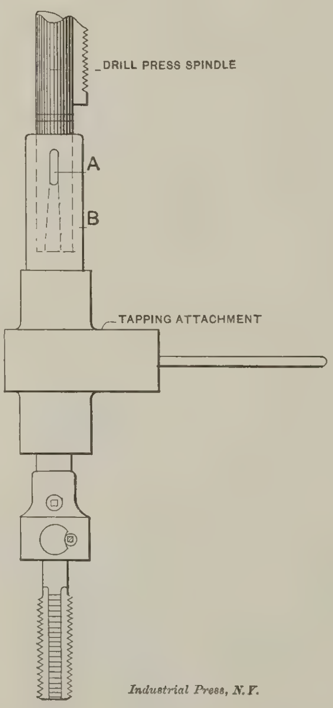
Industrial Press, N.Y.

Fig. 2.

Fig. 2 shows another form which in the writer's opinion is more practical and considerably easier to make. It is a plain blank having a hole ⅛ inch larger in diameter than the arbor upon which it is to be used. The edge *C* is turned to the desired shape and cut in as at *D* to make a cutting point. When in use the cutter is set as at *E* so that cutting point is highest. This style of cutter will produce very satisfactory work and can be ground on the face of cutting point without materially changing shape.

F. E. S.

FOR HOLDING TAPPING ATTACHMENT TO DRILL HOLDER.



Industrial Press, N.Y.

Having read several articles in Machinery on different ways and methods of holding tapping chucks securely in drill press spindles, all of which are not very effective, especially when doing heavy tapping, I enclose a sketch of a tapping chuck and method of securing same to an ordinary drill press spindle, which will be readily understood.

The sleeve *B* takes the place of the usual taper shank furnished with the chucks and is made an easy fit over the drill press spindle with an oblong hole to match drift slot in the spindle and is held in place with the key *A*. The sleeve is easily made and does away with the annoyance of the chuck continually falling out and the expense of twisted tangs and ruined spindles.

C. Bardon.

Anaconda, Montana.

HOW A BASTARD FILE WAS USED FOR KNURLING.

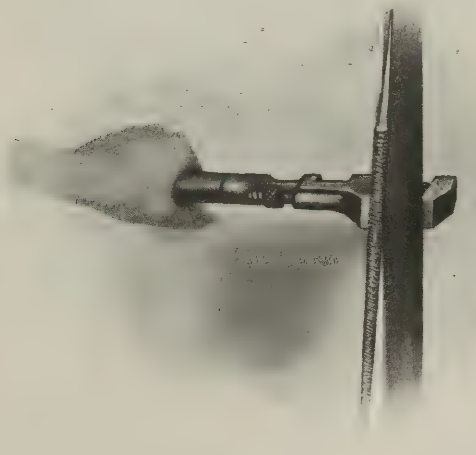
I was once working in a small contract shop—one of the shops in which every imaginable kind and sizes of jobs are done on a lathe of a swing somewhere between 12 and 36 inches. Well, one day the manager, superintendent and general foreman (who was also the owner) came down in the shop and told the foreman and shop crew (that was me) he wanted one dozen 1½-inch nuts, twelve thread. They were to be round on the outside and 2½ inches in diameter. He said they were to be used as hand nuts and that I should file notches on the outside or rough them up some way so as to furnish a hold for the fingers.

I found a piece of cold rolled shafting 2½ inches diameter and about 6 feet long, chucked one end in the lathe and let the other run in the steadyrest. One end was bored and threaded of a sufficient length to make three nuts. I then laid a block of wood across the lathe carriage, put a long parallel bar on the timber, then two short rollers and another parallel bar which came within about 3-16 inch of the bottom side of the work. I then hunted up an old bastard flat file and placed it on top of the last bar and loosened the top screw in the steadyrest just enough to allow the point of the file to roll in under the end of the shaft. The lathe was then turned by hand backward and forward, at the same time increasing the pressure with the screw at the top. I found that this made an excellent job of knurling and after cutting those nuts off you could not tell them from "store bought."

C. P. L.

AN EXTEMPORIZED PIPE WRENCH.

At one time I had the pleasure of helping a neighbor out of his troubles by a little "dodge" in the mechanical way, and thinking it would benefit many of your readers I will tell you about it.



It so happened that my neighbor found a bad leak in his water pipes in the house one evening, and it became necessary for him to take some of them apart in order to get the repairs from the city. Not having any pipe-wrench he called upon me to help him get the pipes apart, or else to lend him a pipe wrench, but I had no pipe-wrench, so I asked him if he had a monkeywrench. He replied that he had, whereupon we took a 10-inch round file and setting the jaws of the monkeywrench up to within about ⅜ inch from the pipe we placed the file in between them in the manner shown on the cut. By pulling so the file tended to roll in between the pipe and the wrench jaw, we were able to loosen the pipe.

I also find that this scheme works very nicely on any sort of round iron or on studs, etc., as well as on pipe.

Pearl River, N. Y. H. E. Wood.

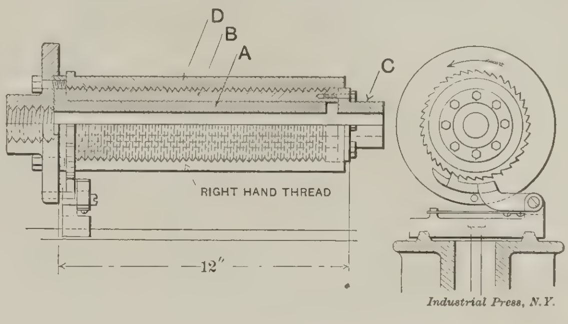
[The writer worked for a few weeks some years ago in a new railway repair shop in Northwestern Pennsylvania; all tools were scarce but the scarcest were pipe-tongs. The consequence was that the men were forced to resort to the above kink whenever any pipe work had to be done. The common practice was to go to the storeroom, get a new file and break it into short lengths, which were used on that job but not saved. On the next job another new file would be sacrificed, and so on. It seemed like a very expensive and inefficient way to get along without the proper tools; it is, however, a good kink to know when an emergency arises.—Editor.]

BORING FIXTURE FOR MOTOR CASTINGS.

Being obliged to do on my 14-inch x 6-foot engine lathe all of the drilling and boring upon a pair of gasoline motors, I made up the fixture described below and it has enabled me to do the work very nicely. The automatic feed I have not yet tried, but used instead a large wood clamp for retarding the revolution of the outer shell or nut, keeping it only tight enough to give the required feed.

Referring to sketch, it will be seen that the inner piece or spindle *A* is let into the faceplate to keep it central and is secured thereto by bolts; it also has a keyway cut its full length.

The center piece or screw *B* is a sliding fit on the spindle and is provided with a key to fit the keyway in same. *C* is the socket for holding the drills or boring bars and is fastened to the end of *B* by cap screws, as shown. *D* is an outer sleeve or nut and is threaded to fit the screw *B*. If this nut *D* is made to rotate slower than the lathe spindle the screw *B* is necessarily forced out as the key prevents turning on the spindle *A*. By using a steady rest on the bar a traverse of 8 or 10 inches can be had.

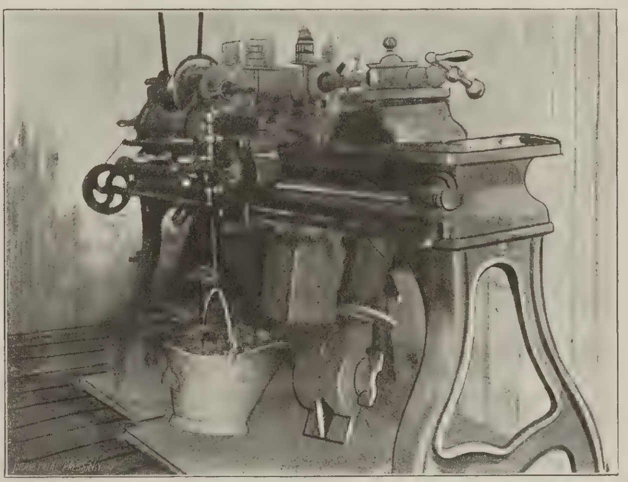


Industrial Press, N.Y.

I inclose a print showing one of the pieces for this fixture clamped to the carriage of the lathe for boring. This photograph may be of interest for the following reasons: First, the carriage of the lathe is not gibbed down, which accounts for the hod of coal and motor casting hung thereto. Second, at the time it was taken the lathe was situated in the cellar with two ordinary small windows on the east side. The shutter was opened at two o'clock on Sunday and the plate left exposed until two o'clock the following day, no artificial light whatever being used.

W. T. Sherman.

Providence, R. I.



CATHEAD FOR STEADY-RESTING SQUARE BARS.

Some time since while working in a small shop some axles of three-inch square steel were sent in to have the ends turned round. There was only one small lathe in the place and that was too short to take the pieces between the centers.

A 3-inch square hole was drifted through a piece of round stock which was then turned down for the greater part of its length so that the steadyrest would take it in. Four holes

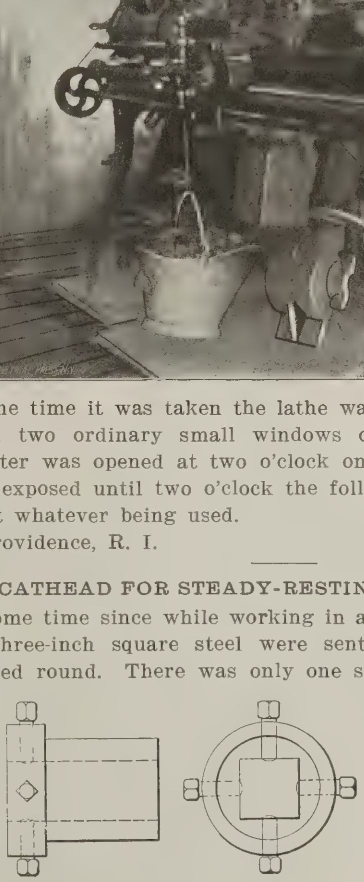


Fig. 1

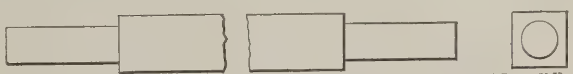


Fig. 2

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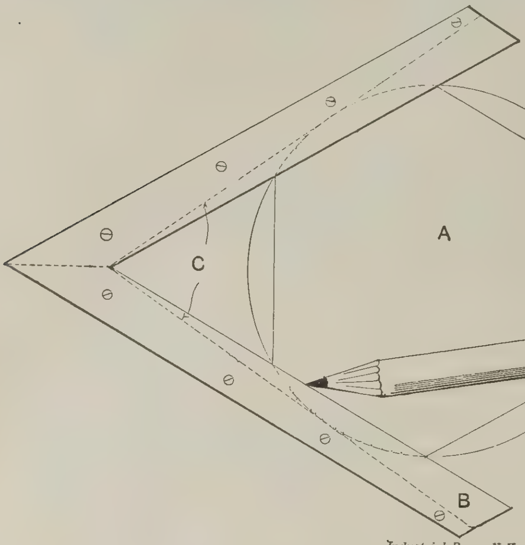
were drilled and tapped for setscrews equidistant around the flange and this was then clamped upon one end of the axle and run in the steadyrest, the other end of the axle being held in the chuck. By this means the ends were readily turned round



Industrial Press, N. Y.

Fig. 1.

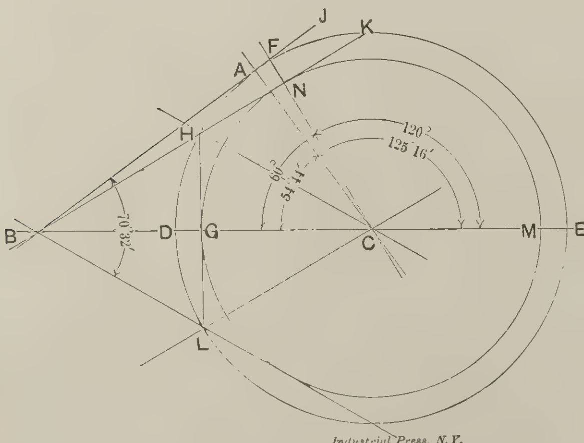
for the required six inches. Fig. 1 (previous page) shows the bushing or cathead, and Fig. 2 the finished axle.

McKeesport, Pa. J. J. Dawson.

TOOL FOR LAYING OUT HEXAGONS.

The cut, Fig. 1, shows a very useful tool for patternmakers for laying out hexagons on the ends of rounds, such as hexagon cap nuts, etc.; it saves the time of spacing around and is just as accurate. I made the tool I use as follows:

B is cut from a brass plate (steel would be better) and the



Industrial Press, N. Y.

Fig. 2.

included angle must be exactly 60 degrees. Fastened to its under side by flat head screws are the two wooden pieces *C* which bear on the circumference of the turned piece when the gage is being used. These pieces must form an included angle of exactly (?) 70 degrees. Although I have been using this tool for years I have never seen another, and for this reason think it may be of interest to others.

St. John, Canada. V. W. Dykeman.

[The included angle between the wooden sides *C* should not be exactly 70 degrees, although this figure is so nearly the exact one that it will answer most practical purposes. The exact angle is 70 degrees 32 minutes, and was determined as follows:

In the construction, Fig. 2, *H L E* represents the circle in which the hexagon is to be inscribed, *G N M* is a circle inscribed within the hexagon, and *B E* is the projected diameter of both circles. Of course we know that a hexagon can be divided into six equal triangles like *H C L*. The three sides of *H C L* are equal and the interior angles are each 60 degrees. The side *H L* is divided into two equal parts, *H G* and *G L*, by the diameter *B E*. The angle *H B L* equals 60 degrees, and *B E* bisects it. *B A C* is a right angle.

$$BG = GC$$

$$BC = 2\,GC$$

$$HG = \tfrac{1}{2}\,HC$$

$$\overline{GC}^2 = \overline{HC}^2 - \tfrac{1}{4}\,\overline{HC}^2 = \tfrac{3}{4}\,HC^2$$

$HC = AC$, therefore

$$\overline{GC}^2 = \tfrac{3}{4}\,\overline{AC}^2$$

$$GC = \sqrt{\tfrac{3}{4}\,\overline{AC}^2}$$

making $BC = 1$, then

$2\,GC = 1$, and

$$2\sqrt{\tfrac{3}{4}\,\overline{AC}^2} = 1$$

$$4 \times \tfrac{3}{4}\,\overline{AC}^2 = 1$$

$$3\,\overline{AC}^2 = 1$$

$$\overline{AC}^2 = \tfrac{1}{3}$$

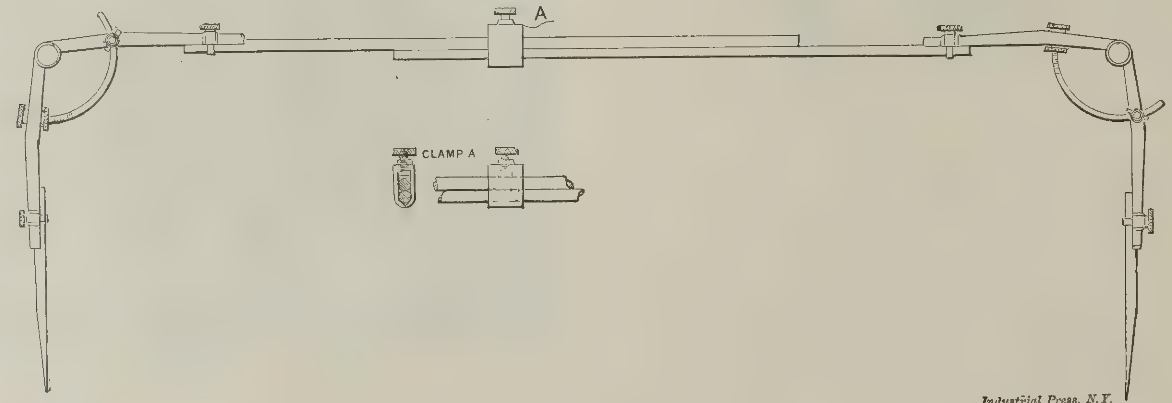
$$AC = \frac{1}{1.732} = .5773$$

.5773 is the sin ∠ 35° 16′

2 (35° 16′) = 70° 32′, or ∠ *A B L*

Editor.]

DIVIDERS CONVERTED INTO TRAMMELS.



Industrial Press, N. Y.

Mechanics in general will be interested to learn how I contrived to get along without buying a pair of trammels. The cut clearly shows the scheme. I was in the habit of borrowing those of my neighbor, till he was tired, and finally told me I would have to "cut it out." "Necessity being the mother of invention," I was forced to devise what you see.

Having two pairs of Starrett's combination dividers I selected a few pieces of 5-16-inch wire from the company's best stock, and when the boss was not looking I did a little "government work" on the clamps. I made two clamps, one for short, and two for long range. There seems to be no limit to this tool in the matter of adjustment, and it is found very handy.

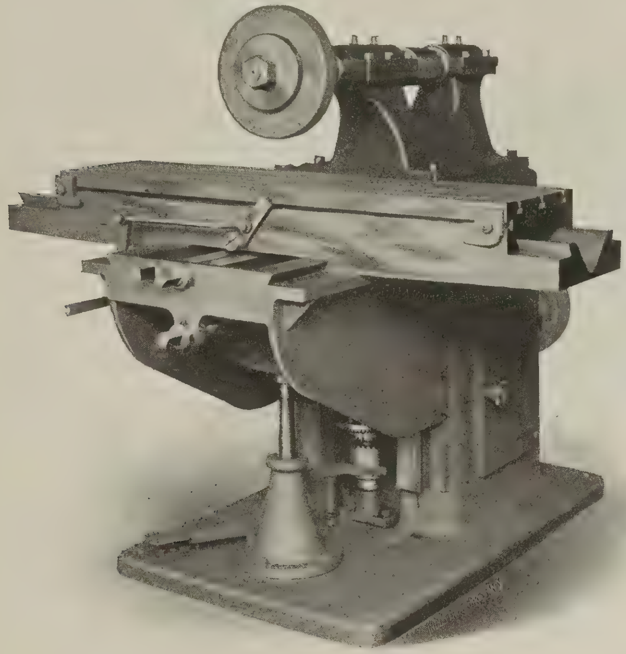
Holyoke, Mass. C. W. Putnam.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

SURFACE GRINDER.

We illustrate below a new surface grinder just brought out by the Goddard Machine Co., Holyoke, Mass. This machine is for finishing dies, brick molds, and for a large variety of flat work. As will be seen, the construction is powerful and durable. The machine takes work 12 inches wide and 42 inches long.



Surface Grinder, Goddard Machine Company.

The steel spindle, 2¼ inches in diameter, is turned and ground accurately and runs in bearings of ample dimensions to give it the required support. It is provided with a fiber thrust collar and nuts to take up the wear. The bearings are adjustable, self-oiling and dust-proof. The table has three T-slots for clamping the work, and, as shown in the cut, power longitudinal feed. Power feed can be applied to the transverse motion when required.

All three motions of the table can be operated by hand, using the same crank handle for each. Power feed is obtained by throwing in the clutch; the power transverse feed operates in either direction or may be thrown out to allow hand feed. The knee has a vertical adjustment of 10 inches.

The principal dimensions are: Height from floor to center of spindle, 48½ inches; length of spindle over all, 41½ inches; size of table, 12 inches by 48 inches; base, 30 by 50 inches; size of wheel, 12 inches by 1½ inches; speed of countershaft, 290 revolutions. The machine complete weighs 3,000 pounds.

COLD SAW CUTTING-OFF MACHINE.

The half-tone herewith illustrates a cold-saw cutting-off machine, for operating on crankshafts, recently brought out by the Newton Machine Tool Works, Philadelphia, Pa. The photograph shows the machine set up with crank in position, as it was tested before leaving the shop. As finally completed for use the machine is supplied with V-blocks for supporting the shaft between the cranks instead of the temporary blocking shown in the illustration.

The spindle of this machine is extended so as to carry two saw blades, making both cuts at one time. To accommodate the varying width of throats the spindle is fitted with a number of washers or collars which are made of various thicknesses. The blades are keyed on the spindles; in addition there are four driving pins for each blade. The spindle is driven through gearing by a phosphor-bronze wormwheel and hardened steel worm of steep lead. The carriage has variable automatic feed by means of friction disk and power quick return, both of these movements having an automatic throw-out.

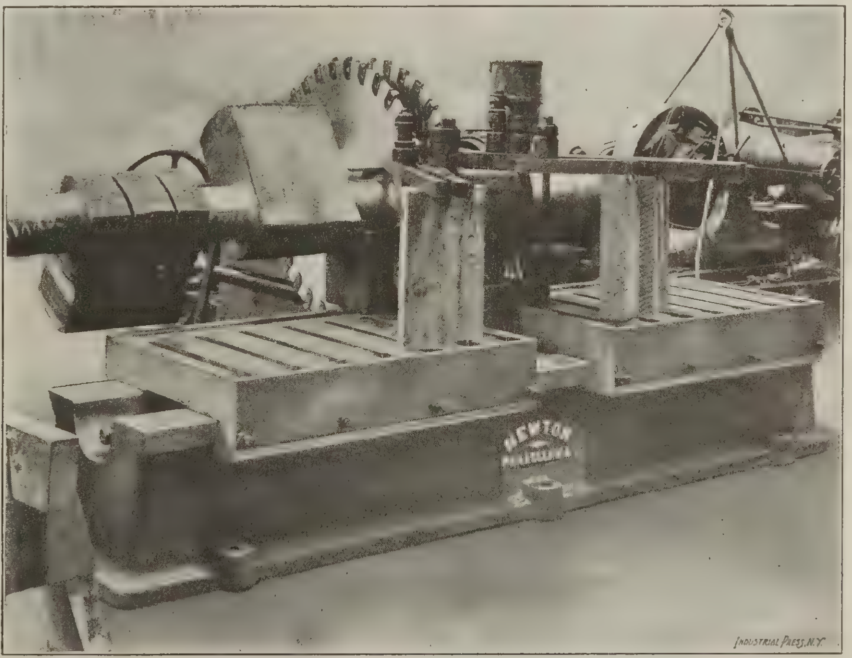
The work tables are arranged so that if the machine is used with only one saw blade, both cuts can be made without unclamping the work. When one blade is used the crank is set on the V-blocks and the carriages adjusted the proper width apart. The crank is then clamped, and after the first cut is made the tables are moved along the bed simultaneously. Carriages are clutched so that they can be operated either independently or simultaneously.

The machine carries either one or two blades, as desired, 36 inches diameter, and will cut to the depth of 11½ inches. It can also be used for round or square stock up to this capacity. The web of the crank shown in the cut is 8¼ inches wide; the blades, which are 9-16 inch thick, were set 5¾ inches apart, the depth of cut being 5⅝ inches. The periphery cutting speed of the saws is 55 feet per minute.

The stock used in this crank was exceptionally hard forged steel of about .47 carbon.

AUTOMATIC RACK-CUTTING MACHINE.

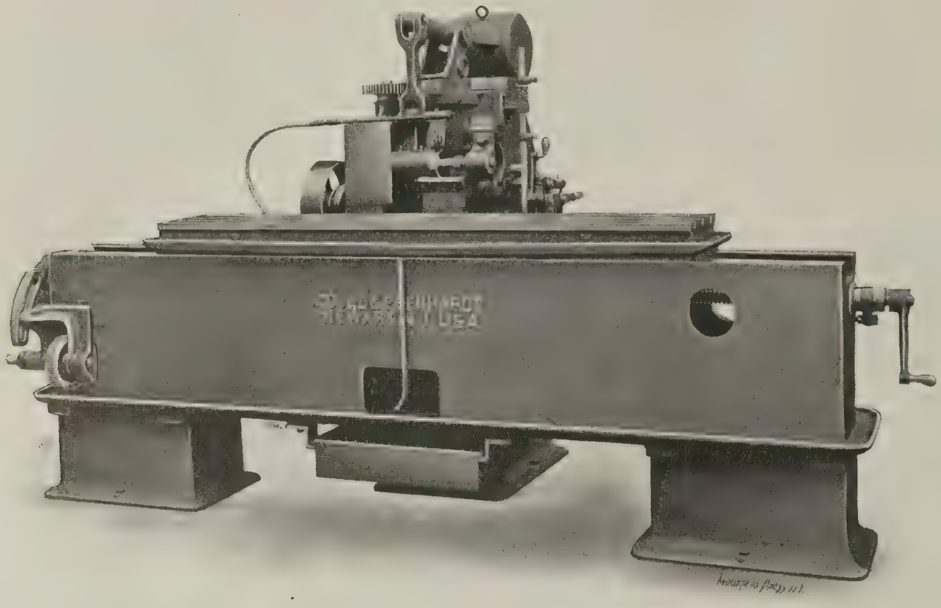
We show on the next page a half-tone of a new rack-cutting machine recently brought out by Gould & Eberhardt, Newark, N. J. The cut shows a front view. This machine is intended for light work, such as for small printing press racks, notching scale beams, and similar work, where great accuracy is required. It has a capacity for cutting racks as coarse as 3-pitch, using a gang composed of one roughing and one finishing cutter, placed side by side; 6-pitch with a gang of three finishing cutters; 8-pitch with four cutters, etc. The gang cutters used on these machines have their cutting points set spirally, and thus avoid chatter and rapid dulling of the edges. The working sides of the blanks are clamped vertically so the cutter slide travels vertically. A funnel-shaped receptacle or opening under the cutters receives chips, oil, etc., which are carried to the bottom of the machine, where the oil is separated and pumped again to the cutters. The



Newton Cold Saw Cutting-off Machine.

cutter slide is counterbalanced and so arranged that it cannot possibly feed downward unless the proper divisions and all previous movements have been completed. The machine can also be arranged to operate semi-automatically if desired.

By an ingenious arrangement on the end of the machine, it can be set to divide for either circular or diametral pitches, using the same lead or dividing screw. It can also be arranged for metric divisions instead of English inch measurements when desired. The cutter spindle is geared very strongly, and as it is driven by worm and wormwheel, affords a very smooth and steady drive. The top of the table is T-slotted, and, with vises for holding the rack blanks, affords a means for cutting any thickness or specially-shaped rack within the capacity of the machine. Any length of rack can be cut by resetting, and the table can be geared to use the traveling movement in either direction, saving wear on the various parts, and obviating the necessity of returning the table every time a new blank is set. The table stops automatically at each end. This light pattern machine is made in 4, 6 and 8-foot lengths.



Rack-cutting Machine, Gould & Eberhardt.

BOLT CUTTER.

A new bolt cutter has been placed on the market by the Landis Machine Co., Waynesboro, Pa. Mr. A. B. Landis, the patentee of the machine, has spent several years in its development and has embodied new principles in its design. The details of the whole machine have been carefully worked up, and it is provided with a carriage of improved form, an improved vise, positive oil pump, etc.; but the chief features relate to the die, which is unique in its conception and produces results that are seldom approached in thread cutting except by the use of the leadscrew on a lathe. The die has four chasers which are made from flat pieces of steel, and the teeth forming the threads are milled on the flat sides of the chasers and extend their entire length, as shown in Fig. 2. This gives a uniform shape to the teeth throughout the chasers and enables the latter to be ground repeatedly without in any way affecting their accuracy or the shape of the threads which they cut. The cutting of the threads is done by the ends of the chasers, and the grinding is done on the ends of the chasers also. The chasers are held in grooved blocks which are secured to four oscillating spindles, which latter are geared together in the head and made to simultaneously open and close the die when adjusting it to the proper size. The blocks and chasers are interchangeable.

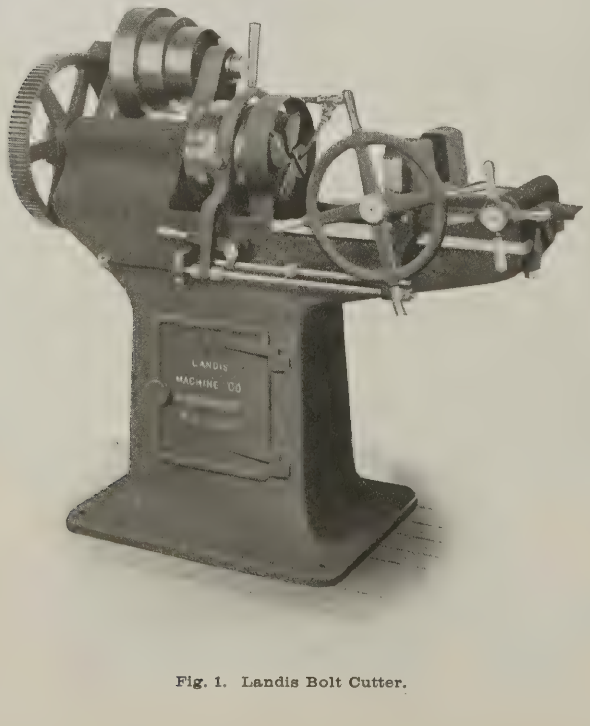


Fig. 1. Landis Bolt Cutter.

The die requires no annealing or hobbing, no retempering, and need never be ground in the throat, inasmuch as the latter is formed by beveling the ends of the chasers their entire length, so that the die is always provided with a throat, however much the chasers may be ground off. The life of this die is many times that of a hobbed die.

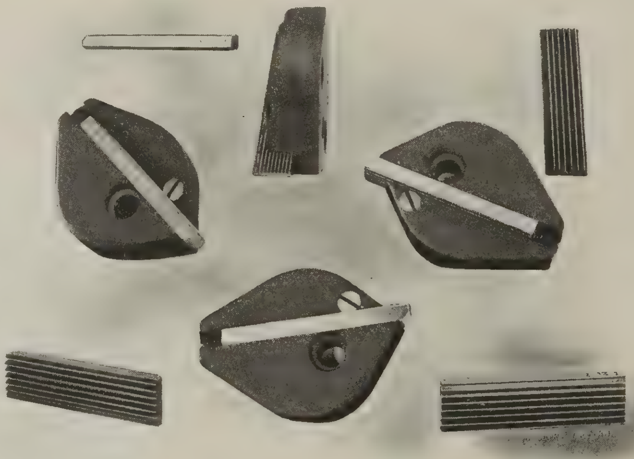


Fig. 2. Chasers used on Landis Bolt Cutter.

In manufacturing the chasers the teeth and throat are milled with special machinery, and care is taken to avoid distortion in hardening. When the chasers are placed in the machine they stand out in front of the head, which allows the chips and scale to fall outside the head where they will not get into the running parts. The chasers are set on lines tangent to the bolt, which gives an ideal clearance, and at such an angle with the thread that the cutting will at all times be done by the front teeth, while the back teeth simply bear against the work and form a permanent lead nut to guide the die. The result is that threads of great accuracy are produced, a piece having been threaded 4 feet long which did not vary more than 1-100 of an inch in pitch in its entire length.

The leading qualities of the die are shown by example 4, in Fig. 3, which is of a ¾-inch rod which was cut down to 5-16 inch diameter and threaded at the same time, without seriously changing the pitch of the thread.

To a limited extent a die of a certain pitch can be set to cut different diameters; for instance, the ⅝-inch die, with 11 threads to the inch, can be set to cut 11 threads on any size between ⅜ inch and 1 inch in diameter. The specimens 1, 2 and 3 in Fig. 3 show a number of operations of this kind, all produced with one die.

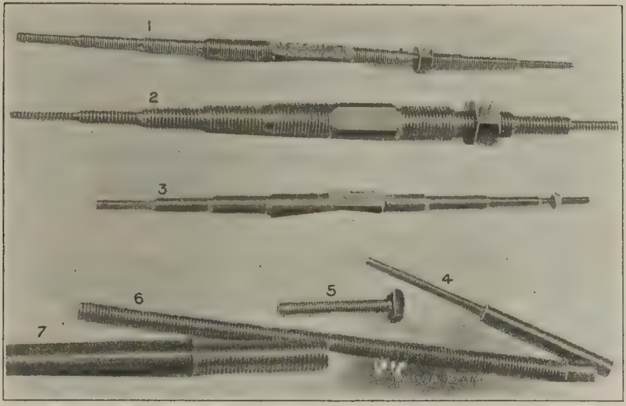
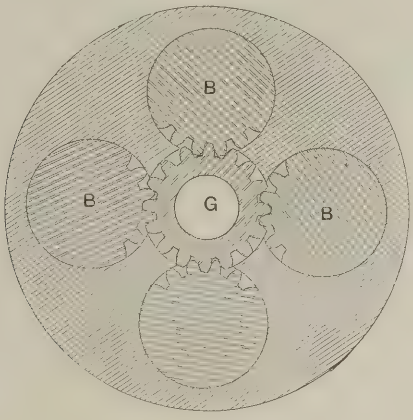


Fig. 3. Specimens of Thread Cutting. Nos 1 to 3 were all Cut with One Die.

As previously stated, four blocks containing the chasers are secured to four oscillating spindles, which latter are geared together by means of a central spindle upon which teeth are cut. In the sectional view, Fig. 4, *B B* are the spindles to which the die blocks are attached, and *G* is the central spindle, made hollow to admit of stock passing through. The rotation of the center spindle *G* causes the four outer spindles to rotate corresponding amounts and the cutters carried by the die blocks to move in or out from the work, as the case may be. There are arrangements for imparting both a slow and rapid motion to the spindle *G*, the former for accurate adjustment of the die and the latter for opening or closing the die by hand or automatically by the movement of the carriage.



Industrial Press N.Y.

Fig. 4.

The mechanism is illustrated in Figs. 5, 6, and 7, the latter showing two different half sections of the die head, one above the center line *A B*, and the other below. Fig. 5 is a cross section on the line *E E* of Fig. 7, and Fig. 6 a cross section on the line *F F* of Fig. 7.

At the left end of the center spindle *G*, Fig. 7, is attached a wheel *H*, having teeth cut in its periphery to mesh with a rack *T*, Fig. 6. This rack is carried by a recess in an outer ring *I*, and can be adjusted longitudinally in the recess by the screw *S*. This gives the fine adjustment to the chasers through the center spindle *G* and the four outer spindles to which the die blocks are attached.

The rapid opening and closing of the die is effected by means of the toggle levers, *M* and *N*, Figs. 5 and 7. One of the levers is pivoted to the outer rotating ring *I* and the other to the body or fixed portion of the die. The opening and closing of this toggle joint is effected by the pinion *P* and the sliding rack *Q*, Fig. 7. The rack *Q* is attached to the sleeve *J*, which slides on the outside of the die head and is moved backward or forward, as the case may be, by a yoke, after the usual manner in machines of this character. A movement of the sleeve *J*, therefore, in either direction causes the toggle joint to move the ring *I* sufficiently to either open or close the die. When the toggle levers are in a straight line, as in Fig. 5, the chasers are locked securely in the position for cutting the threads. Means are provided for so changing the pivot points of the toggle levers as to adapt the die for cutting either right-hand or left-hand threads.

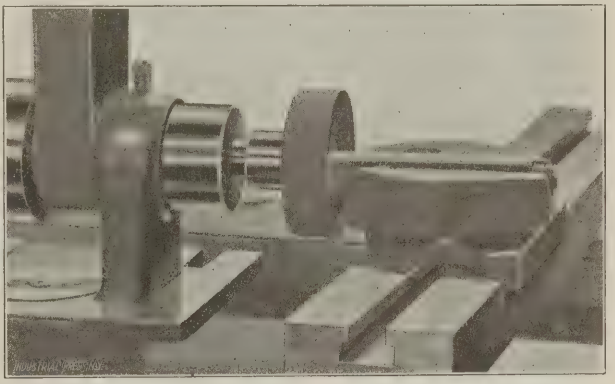


Fig. 8. Grinding the Chasers.

The die blocks are easily attached to or removed from their spindles and the chasers are held in the blocks by means of

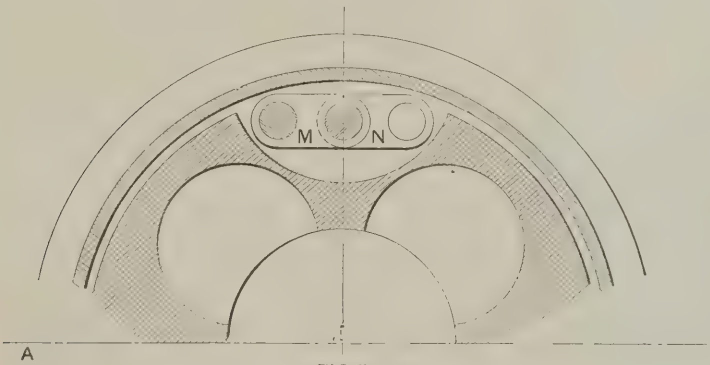


FIG.5

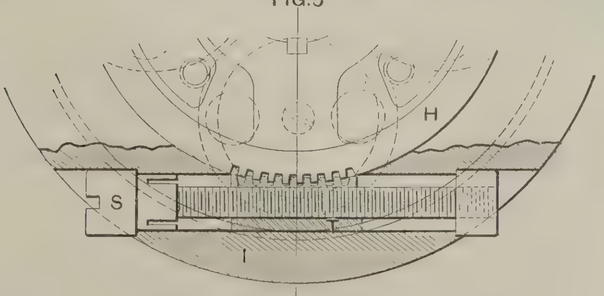


FIG.6

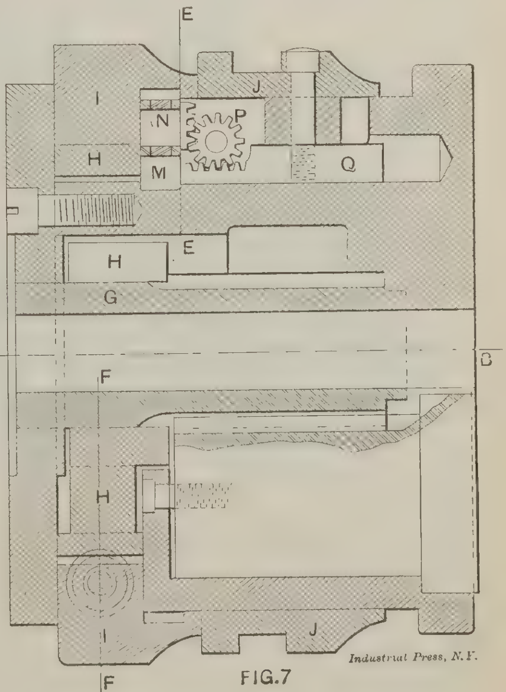


FIG.7

Industrial Press, N.Y.

screws which have annular grooved heads to match the pitch of the chasers. These grooves engage the teeth of the chasers and draw them to a seat in the bottom of the slot, as well as press them against the sides, making the chasers rigid with the block.

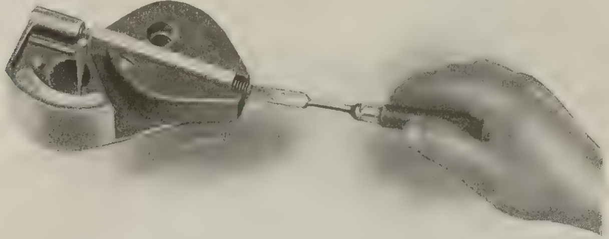
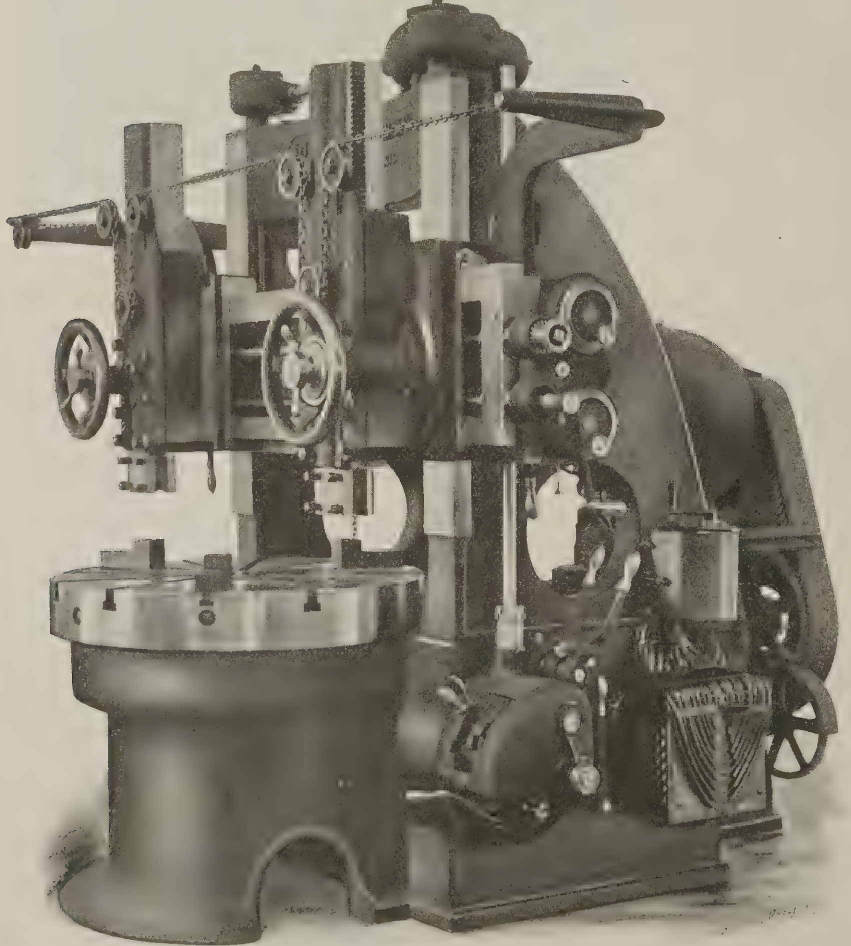


Fig. 9. Adjusting Chaser in Die Block.

Fig. 8 shows a device for grinding the chasers, which needs no explanation; and Fig. 9 shows how, after the chasers are ground, they are again set so as to secure the proper size. The chaser fits in a block and is pushed forward against the pointer of the instrument in Fig. 9 until it registers the required diameter, when it is clamped in position.

GISHOLT BORING MILLS.

A new type of boring mill has been placed on the market by the Gisholt Machine Company, Madison, Wis. This company have heretofore been closely identified with the manufacture of heavy turret lathes and the experience gained in that field has resulted in new features of design which have been embodied in their boring mills. The general features of the lathe headstock used by them, which is of the friction type, backgeared and very powerful, have been incorporated in the boring mills. This type of headstock in its adaptation to boring mills we believe to be new. It has proven very successful in the lathes, and experience shows that it is equally well adapted for the boring mills. It not only gives an efficient drive but is extremely simple and handy of operation.



Boring Mill of entirely New Design, made by Gisholt Machine Company.

Six mechanical changes of speed are obtainable by it and twelve table speeds are given. A lever within easy reach of the operator (as in fact all operating levers are within easy reach) gives absolute control and by reason of the friction device enables the operator to start or stop the machine without touching the motor or shifting a belt. It seems to be a fact that for direct-connected machines there is a decided leaning toward some friction device introduced between the motor and the driving mechanism. By this method much of the time taken up by starting and stopping the motor or shifting the belt is done away with.

If motor drive is used on the Gisholt mill, the motor is mounted directly on the headstock, giving a close connection and at the same time a convenient one, and one that does not necessitate any additional floor space, an important consideration in crowded shops.

The cross rail is raised or lowered by power, the lever for operating the same being located just behind the feed gear boxes. The heads are independent, having separate feeds, both vertical and horizontal, and each is controlled from its own side of the mill. The heads, of course, may be swiveled to any angle. Positive stops are provided so that the down slides may be brought to coincide directly with the table center. By a friction device in the feed mechanism any injury to the heads or gears resulting from their collision is averted. This device will often prove of much value, especially where there is any tendency toward carelessness in operation.

The down slides of this mill are of a particularly stiff and rigid construction, broad bearing surfaces being provided and taper gibs inserted to take up any wear.

A simple time-saving device lies in the micrometer index dials with which both feed screws and feed rods are fitted. While the micrometer index dial has been used on other machines, its application to the feeds of a boring mill is a new thing as far as we know. These dials read to .0010 inch, and in consequence naturally reduce the amount of measuring and calipering to a minimum. Another device in connection with the feeds lies in the feed tripping dials, which may be seen in the illustration at the end of the cross rail. By means of these dials the feeds may be set to trip at any point desired, and by an automatic arrangement will trip at that point when it is reached. A range of ten feeds is given on both vertical and cross feeds, any of which is instantly obtainable.

The right-hand head may be removed and replaced by a turret head. Either the regular head or turret head may be fitted for screw cutting if desired. The spindle is self-oiling and rests on a very broad beveled, babbitted surface, the drive being of the spur pinion variety and powerfully geared. The table may be a universal chuck fitted with movable top jaws, or, if desired, a faceplate with independent jaws may be substituted. At the present time these mills are manufactured in six sizes, ranging from 34 inches to 74 inches

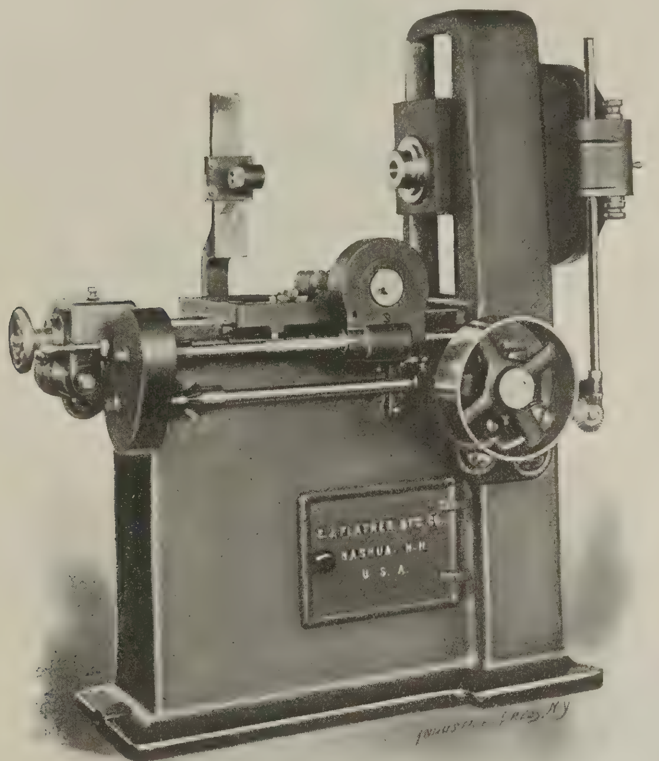
AUTOMATIC GEAR-CUTTING MACHINE.

This gear cutter has been designed to meet the requirements of modern plants for a powerful machine, capable of very high speed The tool, as will be seen in the illustration, is heavy, well proportioned and so designed as to do its work without jar or chatter; while the gears cut—either fine or coarse pitch—are perfectly smooth. Complicated movements have been avoided, each different mechanism being simple in design and positive in action. This machine cuts spur gears to 30 inches in diameter, 9 inches face and 4 diametral pitch. It is also built to cut spur gears 36 inches in diameter.

The head carrying the work spindle is clamped, after the work has been adjusted, by simply drawing forward a lever. The housing is so constructed that in binding the head it is clamped as if solid, yet cannot cramp the work. The head is raised by a screw driven by means of two planed bevel gears and a handwheel located on the side of the machine. This has micrometer adjustment graduated to thousandths of an inch.

The work spindle is a large crucible steel forging bored to fit a No. 12 Brown & Sharpe taper. The carriage has wide bearings on the column, is well gibbed and provided with felt wipers, which prevent the chips and dust from scratching the bearings.

The cutter spindle is hardened and ground, runs in a phosphor bronze sleeve, and ample provision is made for taking up wear. One cutter arbor is furnished, which is hardened and ground and has a strong outer support. A special feature of this gear cutter is the device for locating the cutter centrally with the work, enabling the cutter to be quickly and easily adjusted and clamped in position. The cutter spindle is driven by a powerful worm and worm gear, constantly running in oil, so that all jar and chatter, as the cutter enters the work, is eliminated. The return of the carriage is very rapid, reducing the time taken for both returning and indexing. This return motion is constant and in no way affected by changing the speeds or feeds.



Automatic Gear Cutter made by E. J. Flather Mfg. Company.

The length of cut is regulated by sliding dogs easily adjusted, arranged in such a manner that the carriage may be run back clear of the work without disturbing the dogs. The indexing mechanism is positive in its operation, strongly built, operates without jar, and is locked after each index is made. It is impossible for it to operate after the cutter has entered the work, or to index more than the space for which it is set. The indexing is not affected by any change of speed. The worm driving index wheel can be disengaged from the driving rod by a fine tooth clutch, the work revolved in either way, and the clutch re-engaged. This clutch obviates slipping. The driving pulley runs 300 revolutions per minute, but the indexing as well as other operations on the machine can be made by pulling the belt very slowly by hand. None of the motions of the machine depend on momentum to complete their movement, or friction to carry them. Both the work arbor and cutter arbor are drawn into taper sockets by drawbolts, which also eject them. All cylindrical bearings are ground, and flat bearing surfaces are scraped to surface plates. The machine complete weighs 2,500 pounds. It is built by the E. J. Flather Mfg. Co., Nashua, N. H.

BECKER-BRAINARD FOURTEEN-INCH CUTTER AND REAMER GRINDER.

The cutter and reamer grinder shown in Fig. 1, and doing characteristic work in Figs. 2 to 5 inclusive, is being manufactured by the Becker-Brainard Milling Machine Company, Hyde Park, Mass., to fill the want for a machine capable of grinding heavy cutters of large diameter and long face, such as are used on large column and planer-type milling machines; also for conveniently handling large diameter inserted tooth face cutters. The machine will handle all styles and ordinary sizes of cutters, including plain, straddle, form and end mills, etc. Unlike most other grinders it requires no extra fixtures for handling any style of cutter or reamer. It has two separate work columns, each provided with its own slides. The cutter is transferred from one to the other for the different operations on the side and end teeth.

The main work column has a knee with saddle and table having 6 inches vertical adjustment. The saddle and table swivel around the column in either direction. The column is graduated so that setting can be quickly made for proper clearance with different diameters of emery wheels. The table is fed by rack and pinion, having a longitudinal feed of 20 inches and a cross feed of 7 inches. It is provided with a graduated swivel head which carries a bar on which to mount the cutters.

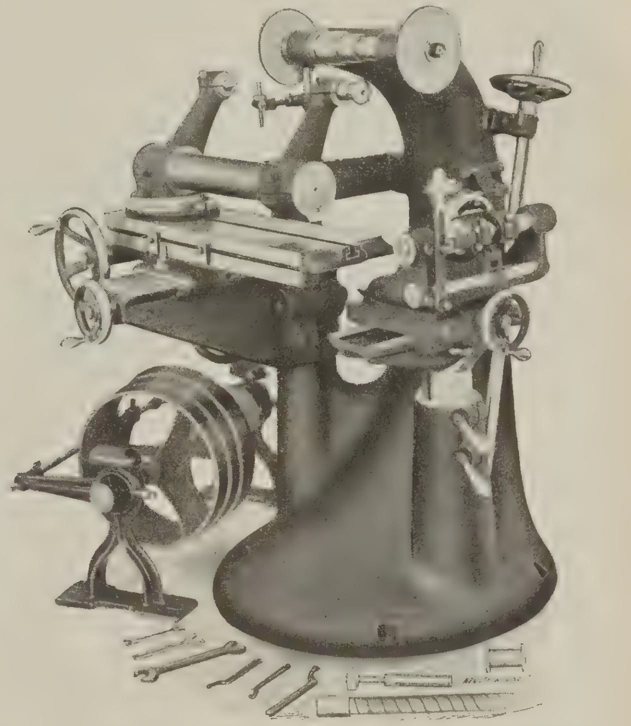


Fig. 1. New Cutter and Reamer Grinder, adapted for Large Milling Cutters of all Types.

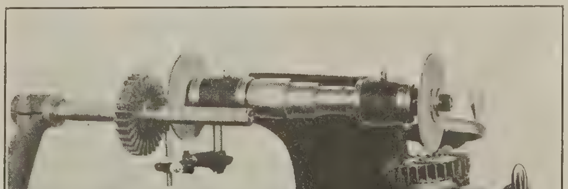


Fig. 2.

The cutters are preferably ground by sliding them on the bar in front of the wheel, as this insures the cutting edge being straight and true with the hole.

The auxiliary column with slides, at the side, is provided so as to make unnecessary the special fixtures usually required, and, as it is always at hand, no time is lost in setting up for jobs out of the ordinary run. The second column has a swivel

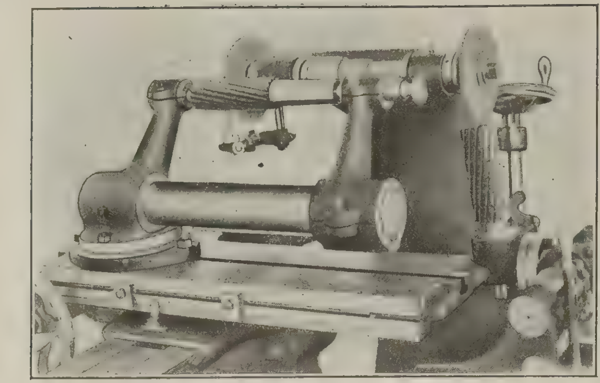


Fig. 3.

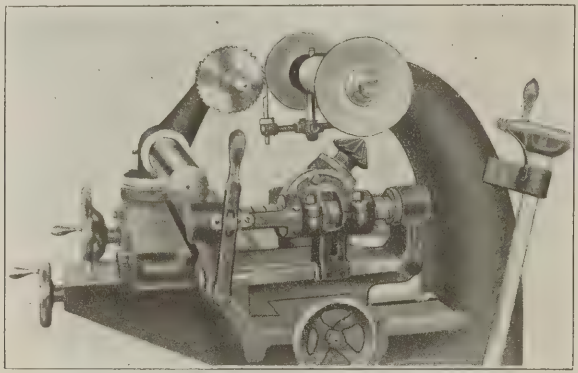


Fig. 4.

carriage carrying two cross slides, the top slide having 7 inches traverse and the lower one 9 inches traverse at right angles. The top slide carries a swivel head or holder sliding on a horizontal bar which permits 5 inches traverse. With this fixture, which is used for grinding the end teeth of mills and cutters, it is unnecessary to use any other but the 7-inch emery wheel shown in the cuts.

Fig. 1 shows the belt-driven machine; it is also made electrically-driven, in which case the motor is mounted on the back of the frame column and is belted up to a countershaft secured to column by brackets, so that it stands some distance above the grinding spindle. From the countershaft a belt, of course, leads to the grinding spindle pulley. Advantage is taken of the countershaft brackets for a convenient location for the starting box or rheostat. One of the electrically-driven machines is being shown at the St. Louis Exposition.

Figs. 2 to 5 inclusive show some samples of work done. Fig. 2 shows the machine grinding the ends and sides of straddle mills; Fig. 3 of end and side cutting mills. Fig. 4 shows a slitting saw on the grinding bar and the auxiliary head at the side swiveled for grinding the teeth of a bevel mill. Fig. 5 shows a large inserted tooth face mill in position on the sliding head. This is a difficult cutter to handle on most grinders without special fixtures, but on this machine it is a simple operation.

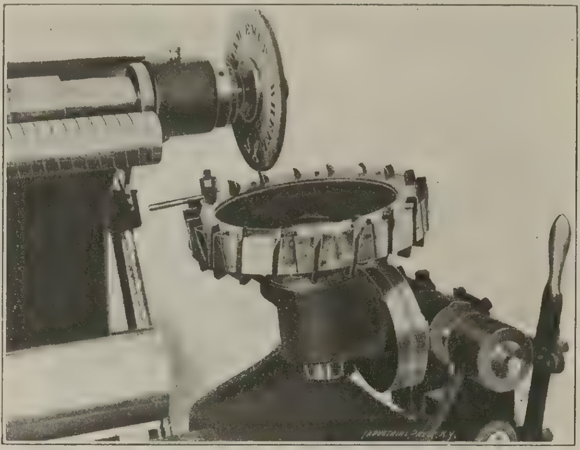
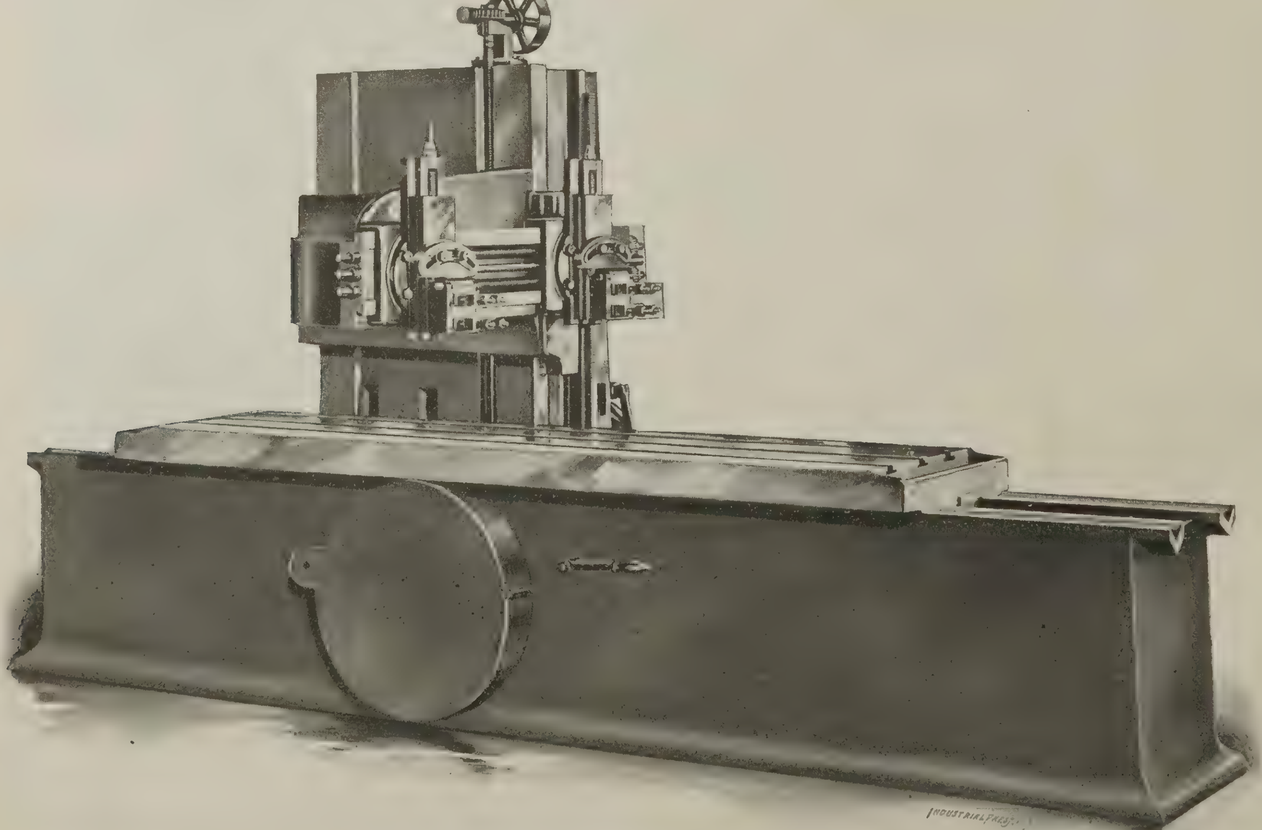


Fig. 5.

OPEN-SIDE PLANER.

The features of the open-side planer here described are simplicity of construction and rigidity to meet the increased strains of modern work. The tool is made box section throughout.

The bed is cast closed on the upper surface and is ribbed at intervals, there being three cross partitions opposite the base of the column, which is itself cast solid with the bed up to the level of the table. The upper column, which is box section, rests on broad flanges and is secured to the base.



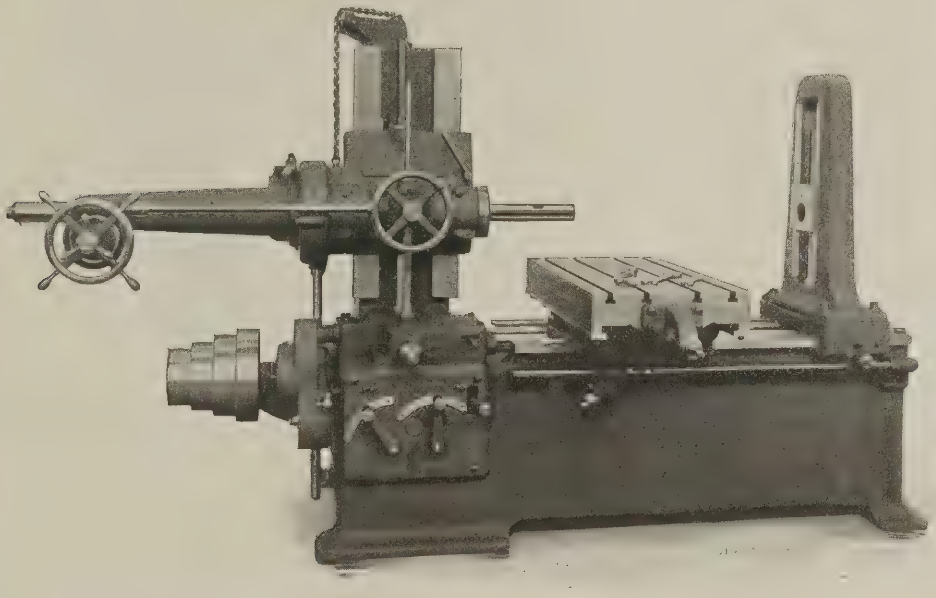
Open-side Planer made by Cleveland Planer Company.

The Vees are 100 degrees, giving ample bearing and ease of running. Oil pockets are provided with automatic oilers carrying the oil to the top of the Vees, insuring perfect lubrication. The cross rail is square gibbed, both front and back, the front gib being cast solid with the rail.

The larger sizes of this machine are equipped with side heads, which operate independently of cross rail heads, and with the cross rail removed can be operated to the full height of the column. All the gears are encased. Feeds are all automatic in all directions, and can be operated from either side of the machine. No part of the machine extends below the floor. The belt shifting device is simple, shifting one belt at a time without shrieking. The table return is from 2½ to 1 to 4 to 1, as desired. The drive can be set either parallel with or at right angles to the bed, and the machine is adapted to either belt or motor drive. It is built in sizes 30, 36, 42, 48, 54, 60 and 72 inches, and any length, by the Cleveland Planer Co., Cleveland, O.

PRECISION BORING, DRILLING AND MILLING MACHINE.

The foundation principle of this machine, as in the larger one made by the same company, the Lucas Machine Tool Company, Cleveland, O., is raising and lowering the spindle head, and with it the outer support for the boring bar, which is a constant weight, instead of the platen, with its load, which is widely variable.



Lucas Horizontal Boring, Drilling and Milling Machine.

This construction also makes possible the use of an exceedingly deep box bed, resting on three points, thus eliminating the necessity and expense of a foundation for the machine, and incidentally making it a matter of small expense to set the machine in a new location, if desired.

The yoke carrying the outer support for boring bar is fitted to the bed and easily adjustable by a wrench to any point desired along the bed. Pieces of work longer than the nominal range of the machine may be drilled and milled and holes of such a length that the outer support for boring bar is not needed may be bored, by simply removing the upper portion of the yoke, which in this form of machine leaves the table as stiff and in every way as strong and efficient as before.

This machine is of such general dimensions as to nicely adapt it to automobile engine work, and the cross motion of the platen is sufficient so that cylinders and similar work may be bored and faced on the front and back portions of the platen alternately, thus making it possible to set one piece of work in position while the machine is at work on another.

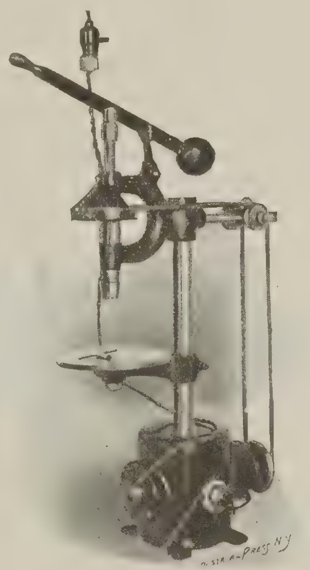
The platen also has a milling feed, and the vertical milling feed to head, which is a regular feature of the larger machine, may be applied to this machine when desired.

The screws are all precision screws, cut in special hard steel, with adjustable dials graduated to thousandths of an inch, so that holes may be bored or surfaces milled an exact distance apart without jigs, and what is of more importance work may be varied when an opportunity for improvement in design comes, without the necessity of throwing away or making over expensive jigs.

The spindle is crucible steel, and all working parts are ground or scraped. The machine is fitted with all modern improvements in the way of quick power moving devices, geared feeds, friction safety devices, etc., and it is adapted for either belt or motor drive.

BENCH DRILL.

An exceedingly neat electrically-driven bench drill has been brought out by Bartz, Wygant & Brown, Hornellsville, N. Y. The motor which operates the drill forms the base of the machine and is supplied with lugs for attaching the drill to the bench. The drive is by a round belt, as shown, two belt speeds being provided. A sensitive lever feed is supplied. Other speed changes are obtained in the motor itself and current is taken directly from a lighting circuit of 110 or 220-volt current, by attaching to a lamp socket. The capacity of the drill is for holes up to ¼ inch in diameter. Its weight is 100 pounds. The driving pulleys on the spindle are protected by a suitable shield. The table may be adjusted into any position, vertically or horizontally, by sliding on the cylindrical column.



Bartz, Wygant & Brown Bench Drill.

AUTOMATIC DIE-HOLDERS.

A new automatic hollow shank die-holder for screw-machines has been brought out by the Garvin Machine Company, New York, and is shown in the cut, Fig. 1. This die-holder is specially designed for high speed, and overcomes many of the defects which develop in these tools, when used under such conditions. It is clutched positively, going forward; but on reverse, when the die is in rapid rotation, and must be stopped, it is held by friction grip, so that it is noiseless in action, and reverses without shock and clatter. The die reverses itself instantly and automatically on throwing the shipper and begins to run back of itself. The hollow shank permits long work to pass clear through, but the working parts are protected from chips and grit.

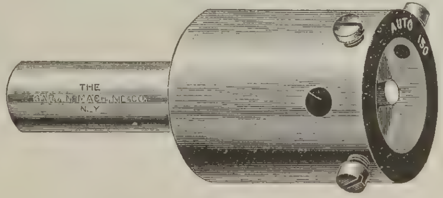


Fig. 1. Garvin Die Holder.

The construction of the die-holder is readily understood from Fig. 2. The sleeve *A* carries the die in the recess *B* and is mounted on the shank *C*, which goes in the turret. When running the die up on the work the sleeve *A* is clear to the left and is clutched to the shank *C* by the square clutch pins *D*, which lock the sleeve from rotating. When the turret slide strikes the stop, the die is drawn forward until the pins *D* are out of engagement and stand in the position shown. The ring *E* prevents the sleeve *A* from sliding too far forward.

On reversing to run the die off, the sleeve *A* starts to rotate with the work, but is checked at once without shock by the three friction pawl rollers *L*, shown in the end view. Three grooves are milled in the body of shank *C*, and in each groove is a roller, *L*. A flat spring *M* keeps each roller over toward the side of the groove. When the sleeve *A* starts to rotate in the direction of the arrow, on reverse, the rollers *L* bite at once on the inside of the sleeve *A*, which is hardened, and hold it from rotating while running back. When the sleeve is rotating free with the work in the opposite direction to that of the arrow, just previous to reversing, the rollers *L* oppose no resistance. The shank *C* has a hole *G* clear through to pass long work ,and the tube *F* prevents chips and grit reaching the clutch parts. Egress for chips is provided by openings *H*.

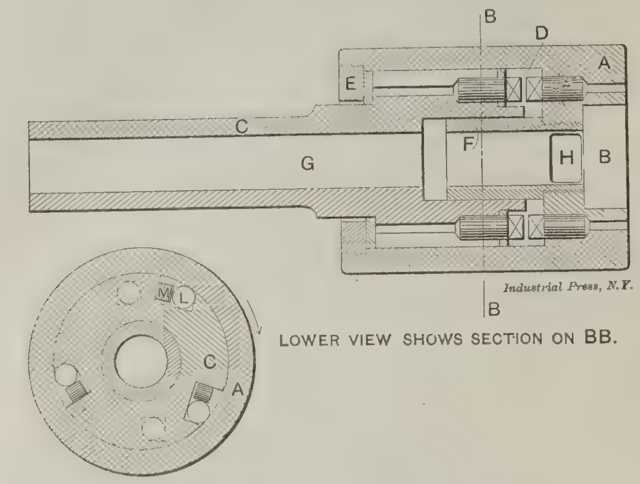


Fig. 2. Details of Die Holder.

O. K. PLANER TOOL HOLDER.

The O. K. Tool Holder Company, Shelton, Conn., have just brought out the heavy planer tool holder shown in Fig. 1, which is particularly well adapted to the economical use of the costly grades of high-speed steel. The tools, shown in Fig. 2, are drop forgings, made in the characteristic forms adopted by this concern, that is, with a shank fitting into the holder and the body of the cutter resting on a shoulder so that the thrust of the cut is sustained in the most rigid and secure manner without imposing excessive strains on the locking screw. The method of locking the cutters is simple and unique. The locking nut, shown behind the cutter in Fig. 1, fits a short stud which is notched at its lower end, and in this notch is fitted the inner end of the locking wedge. When the nut is tightened with the wrench the stud is lifted and the wedge is forced outward against the back of the cutter. Because of the peculiar construction of the tool holder, as just mentioned, the force required to hold the cutters in position is a minimum. For this reason the convenient method of locking can be used, and with it there is no trouble from twisted setscrews, etc. The holder is of the offset variety, the working edge of the cutters being located back of the shank. The shank measures 16½ inches in length and 1¼ x 2 inches cross section. Twelve tools made of Novo steel are supplied with the holder; the finishing tool shown in the holder has a 1¼-inch face which gives an idea of the strength and size of the tool. Each tool is positively located by the locking wedge so that when grinding becomes necessary, it may be removed, sharpened and replaced without disturbing the holder or the precise setting of the cutter.

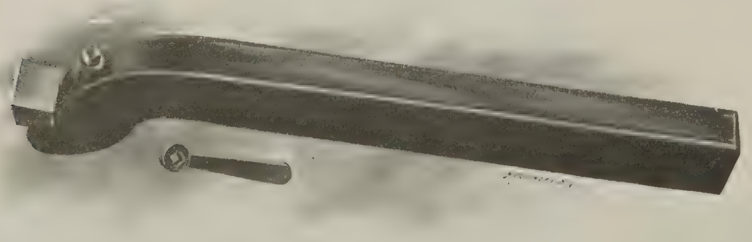


Fig. 1. New Planer Tool Holder.

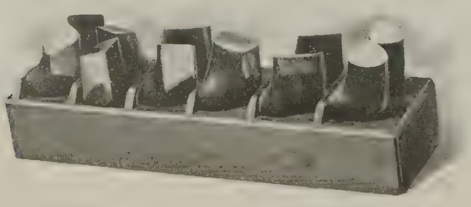
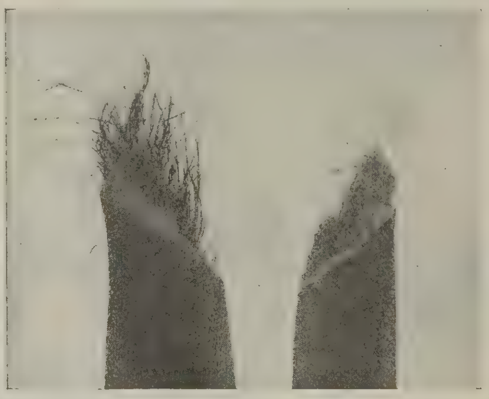


Fig. 2. Set of Tools for Planer Tool Holder.

LEATHER BELTING.

The subject of leather for power transmission purposes is one of considerable importance in a power or manufacturing plant. The E. F. Houghton Company, Philadelphia, Pa., have produced a new mechanical leather under the trade mark of "Vim," for which strong claims are made as to durability. This leather is furnished for belting, friction disks and other similar purposes. We are informed by this company that they do not hesitate to fill an order for leather with guarantee that it will wear twice as long as oak-tanned leathers, and where the strain is severe, as for instance, in hydraulic packings, they state they will even guarantee more favorable results in wear.

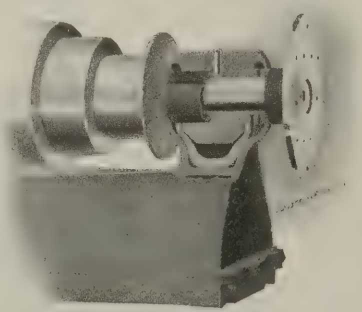


"Vim" Leather. Oak Leather.

The illustration herewith shows a piece of oak-tanned and a piece of "Vim" leather, which were partially cut and then torn apart. The fibers in the Vim leather appear to have been preserved better than in the case of the oak leather and are less brittle. This presumably is the explanation of the superior results that have been obtained with this leather.

PATTERNMAKERS' LATHE.

A 10-inch patternmakers' lathe, especially designed for manual training schools, has been placed on the market by Fay & Scott, Dexter, Me. This lathe is neat in design, substantially built, and has self-oiling bearings in the headstock. A sectional view of one of these bearings is shown in the accompanying figure. There is an oil chamber beneath the bearing with a wick feed for the oil, and annular grooves at each end of the bearing return the oil to the reservoir.



Main Bearing of Fay & Scott Lathe.

The lathe spindle is of high-carbon steel and runs in bronze boxes. The rest holder and tailstock are fastened to the bed by a cam lever which operates instantly and positively and serves as a handle for moving these parts on the bed.

COMPOUND VERTICAL SPINDLE MILLING ATTACHMENT.

This attachment is for use on different sizes of plain and universal milling machines of the knee type having overhanging arm. It is applicable to a large variety of drilling, spiral milling, milling angular slots in surfaces of any angle, T slots, keyways and work of a similar character. It is rigidly held in position; the upper part of the frame or head being clamped to the overhanging arm and the lower part to the face of the column by means of a heavy bracket.

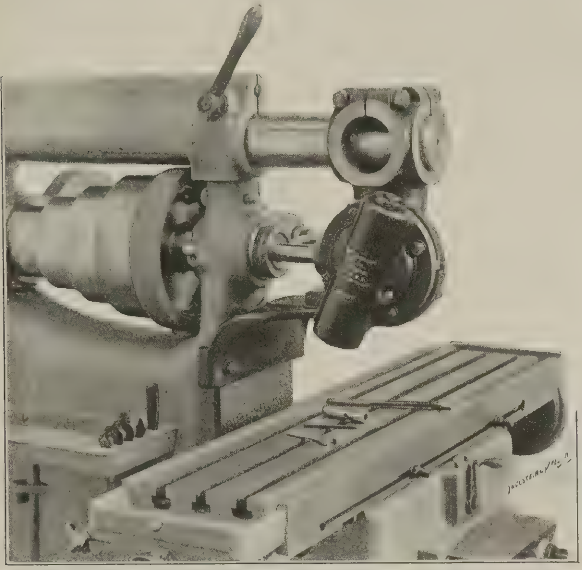


Fig. 1. Compound Milling Attachment; it may also be attached to the Spindle at right angles to position shown.

The illustration, Fig. 1, shows the attachment in place so as to mill in a plane at right angles to the milling machine spindle. The attachment can, however, be set at right angles to the position shown in Fig. 1, so that its spindle will swing in a plane at right angles with that of the milling machine spindle. It will be noted from the illustration that the attachment is bored out with two holes at right angles with each other, to fit the milling machine bar; and that the attachment has two hollow spindles at right angles with each other, by which it can be driven from the milling machine spindle in either position.

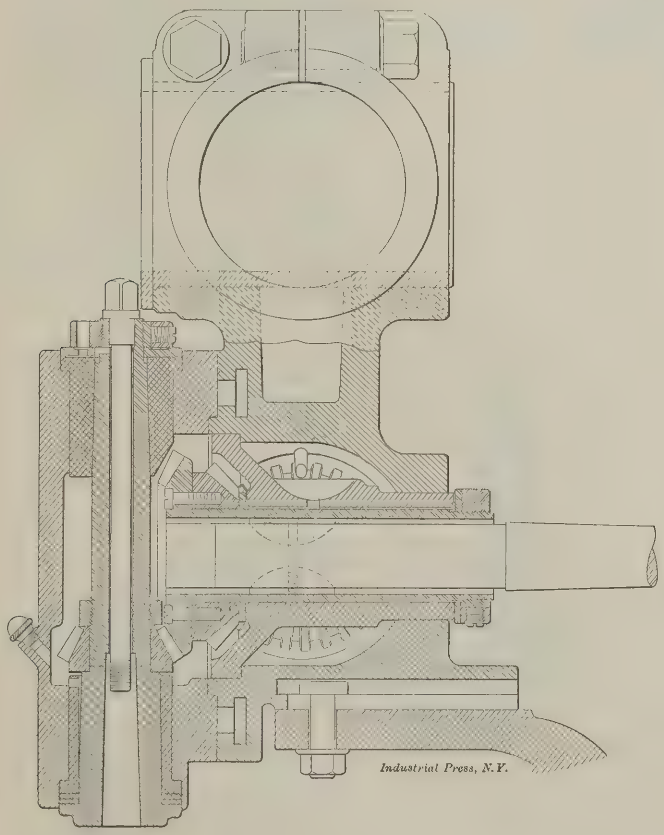


Fig. 2.

The spindle is driven through bevel gears by a horizontal shaft inserted in the main spindle of the machine, and can be set to any angle from a vertical to a horizontal position. A valuable feature of the device is that when set in a plane at right angles to the table, annular milling can be performed by an ordinary end mill, and the full travel of the table is available for such work. It is therefore well adapted for milling long angular strips, lathe ways, etc., where ordinarily an angular cutter would be required.

The position of the spindle is indicated by graduations on the back of the head, reading to degrees. The spindle has a No. 7 taper hole, and a draw-in bolt is furnished for use in holding collets in the spindle. Details of the device are clearly shown in the sectional view, Fig. 2. This attachment is manufactured by the Brown and Sharpe Mfg. Co., Providence, R. I.

REAMERS WITH HIGH-SPEED STEEL BLADES.

We illustrate below a hand reamer and a shell reamer whose chief feature is that the blades are of high-speed steel. The tools themselves consist of a body of soft steel, to which are brazed blades of high-speed steel, making a solid reamer. The advantage claimed by the manufacturers, the Three Rivers Tool Co., Three Rivers, Mich., is that whereas the use of high-speed steel for reamers has not been practicable owing to the great cost of the stock, reamers like those shown can be had at a slight increase over the cost of the ordinary tool, yet securing the advantages to be derived from the use of high-speed steel.

A large center is provided so as to prevent the reamer from slipping from the tail center and cutting a groove in the end of the shank. This center is casehardened, as is the flat for the point of the dog screw. The square on hand reamers, the tangs on drill reamers and the shanks fitting turrets of the chucking reamers are likewise casehardened. These tools are ground all over after all hardening operations are completed. Fig. 1 shows the hand reamer; Fig. 2 the shell reamer.

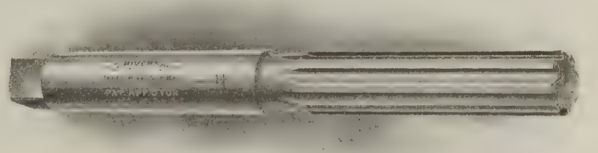


Fig 1. Hand Reamer.

It is often desired to expand a solid reamer (either hand or machine). Owing to the soft body of the reamers here shown a hole may be drilled in the center of the fluted end, slots cut in the grooves, and a taper pin or screw used to expand the tool in any of the ways in common use. The Three Rivers Company have sent us some data regarding results obtained with these tools in the shops of the Sheffield Can Co., of their city, which certainly prove the efficiency of their reamers. They are made in any style desired.

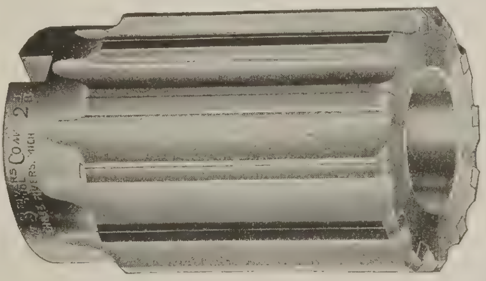


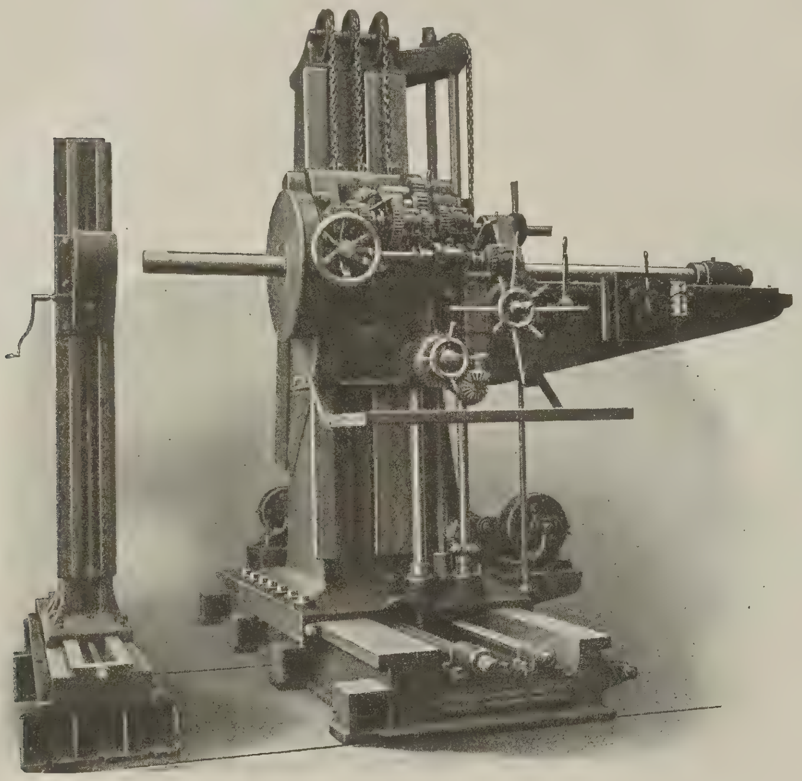
Fig. 2. Shell Reamer.

The Charter Gas Engine Company, Sterling, Ill., have brought out a small horizontal type of engine to meet the demand in small sizes for a reliable engine that can be purchased at a low price. We are informed that the machine is substantial and the workmanship good, although the cost of production has been reduced to a minimum.

HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

This machine is a new production of the Detrick & Harvey Machine Company, Baltimore, Md. The saddle carrying the spindle has a vertical movement on the face of the column of 72 inches and the column has a movement of 72 inches (or more if desired) on the runway. Fast and slow movements are provided for the saddle and column; and power feeds and quick return for the spindle in either direction. There are also hand feeds for all the different motions.

The runway is a heavy box-shaped casting having a front slideway 14 inches wide and a rear slideway 8½ inches wide. The width over all is 56 inches. The driving gearing and motor for operating the spindle and feeding column and saddle are located at the rear of the column.



Seventy-two inch Horizontal Boring and Milling Machine.

The spindle is of hammered steel, 5½, 6, or 6½ inches in diameter with a No. 6 Morse taper hole in the end. It is ground to a fit in a sleeve 46 inches long. The sleeve is slightly tapered on its outside and revolves in a bronze bushed bearing 37 inches long in the saddle. Bronze thrust and take-up washers are provided. The work bed is 12 inches deep, tongued and bolted to the runway. The outer support for the bar is fitted with a stationary bushing which has a bearing of 24 inches on the face of the post.

There are eight boring and drilling feeds, which are reversible, and range from .007 to .4 per revolution of spindle. The saddle and column are also provided with eight milling feeds ranging from .01 to .5 per revolution of spindle. The spindle speeds are 20 in number, 10 through the sleeve gear and 10 through the faceplate gear. The speed changes are obtained through the cone and by clutches operated by levers. Four changes are obtained by shifting the levers, and without changing the step of the cone. All the several hand levers for controlling the machine are within reach of the operator when standing on the platform attached to the saddle. The rapid movement of saddle and column is obtained from a separate motor mounted on a supplementary base at the rear of the runway.

MANUFACTURERS' DRILL WITH AUTOMATIC REVOLVING CHUCK.

The B. F. Barnes Company, Rockford, Ill., have brought out a new automatic revolving chuck to be used in connection with their 14-inch and 20-inch manufacturer's drills which have self-operating spindles. Fig. 1 shows a two-spindle 14-inch drill, one spindle of which is equipped with the automatic chuck.

The spindles are independent, being driven from quarter-turn countershafts. A chain running from a sprocket wheel on the lower cone shaft drives a sprocket wheel near the top of the machine, which in turn operates the spindle by means of a friction device. The spindle is provided with adjustable stops for regulating the depth of travel. As soon as the automatic stop has thrown out the feed the spindle is immediately backed out of the work and returned to its first position by means of the friction device mentioned. There is a cam mechanism on the other side of the spindle which throws in the feed at the moment the spindle has descended to the work. This cam has two stop pins, one of which causes the spindle, when raised up, to stop until the operator trips same by means of a lever in front of the machine. When using this machine with the automatic revolving chuck, however, the stop is removed so that the spindle, instead of stopping upon the return, will immediately drop down to the work again, drill to the

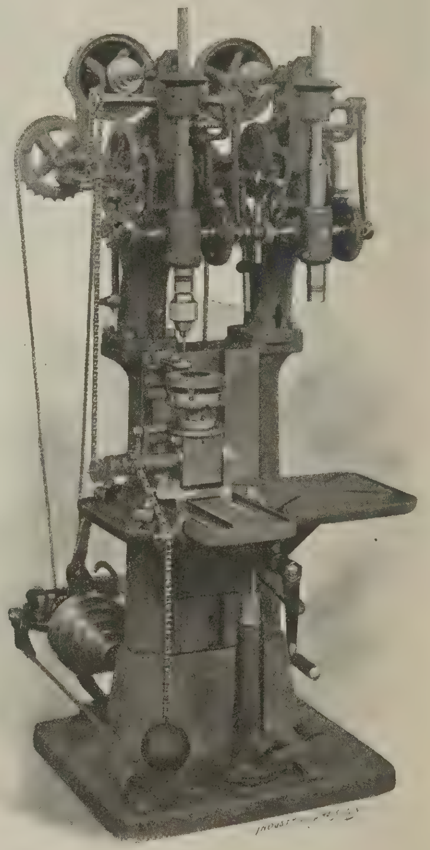


Fig. 1. Manufacturers' Automatic Drill.

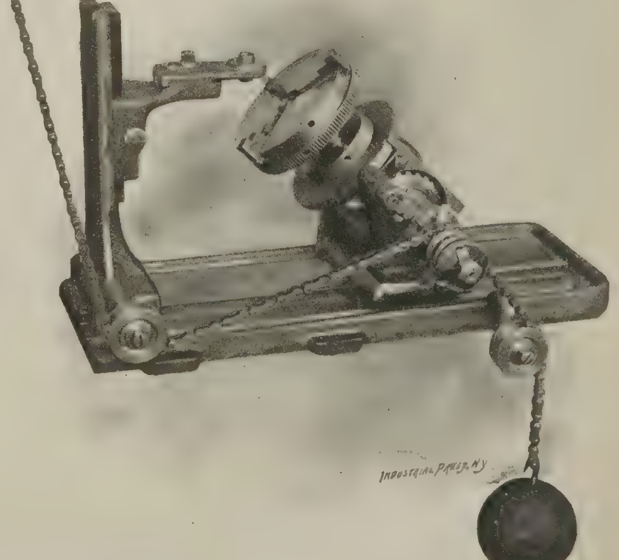


Fig. 2 Automatic Chuck for Manufacturers' Drill.

required depth at proper speed, then quickly return, and so on.

The chain operating the automatic chuck, as shown in both Figs. 1 and 2, is attached to a gear under the control of the friction mechanism mentioned above. This chain carries a weight on the end for taking up the slack. The mechanism of the chuck consists of a horizontal shaft on which is a sprocket, over which the chain passes; and a friction clutch connecting the sprocket with a pair of bevel gears for rotating the chuck. The distance the chuck is spaced is determined by a notched plate. A plunger fits in each notch in succession and is disengaged from its notch and allowed to drop into the next one successively by a spring mechanism operated by the sprocket wheel. The spacing of the chuck occurs when the drill spindle is being backed out of the work.

A plate with any desired spacing of notches can be used, either regular or irregular. Any style of chuck may be used, the one shown being an ordinary three-jaw chuck. Above the chuck is a guide for small drills, which is attached to a vertical arm clamped to the base which supports the chuck. The chuck can be inclined to any desired position for angular drilling. For certain classes of work the spindles of this drill may be equipped with an auxiliary double-spindle attachment whereby two drills may be used at the same time, both operated by one spindle.

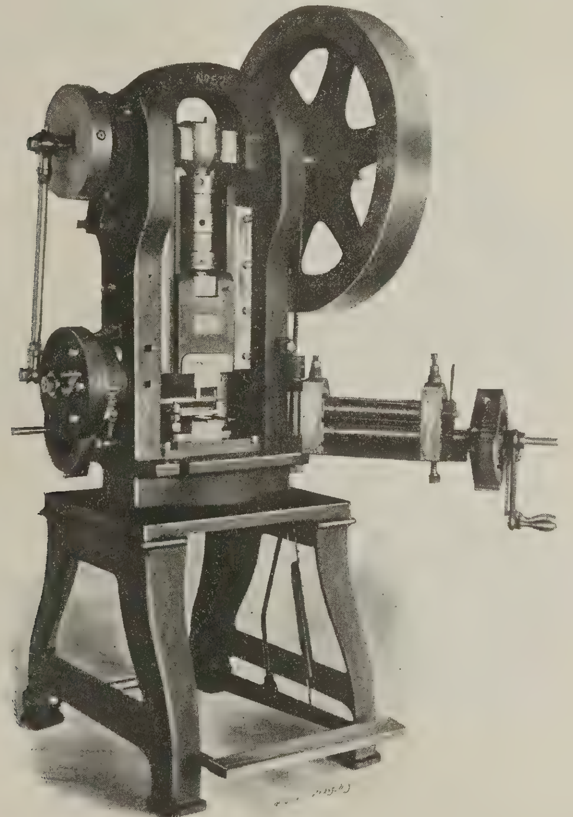


Fig. 1. Coin-cutting Press. Front View.

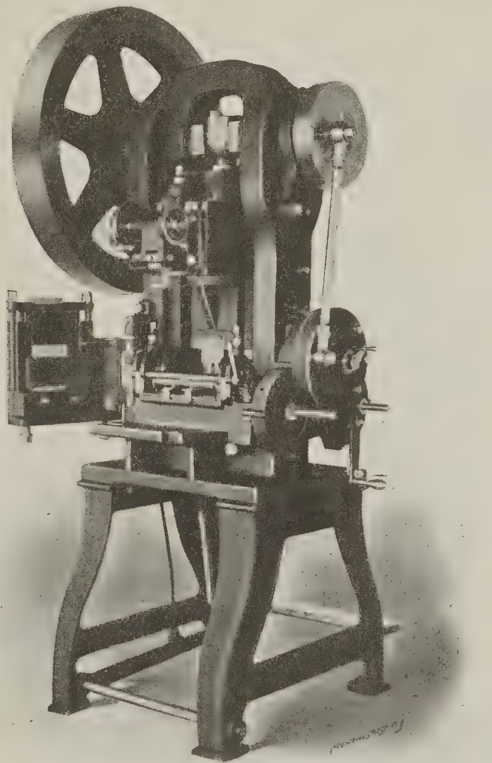


Fig. 2. Rear View.

AUTOMATIC COIN-CUTTING PRESS.

The accompanying cuts illustrate a new planchet or coin blanking press embodying a number of features which we are informed have not been used before on similar presses. A high-speed automatic blanking press was wanted, in which could be had absolute accuracy, easy adjustment of die and punch, ready access to double roll feed and other working parts, and the punched metal taken care of without an extra operator, and the above machine was built to meet these requirements. Fig. 1 shows a front view and Fig. 2 a rear view.

The most important advantage of this machine is the swinging double roll feed with its adjustable feeds and gages. These gages and feeds are not disturbed when rolls are swung out from left to right, leaving a clear die space with no hindrance, either in front or back of die table or press bed. In the older method of lowering the rolls in front or rear of press table, the rolls are not much out of the diesetter's way, as they always project out far enough to be troublesome, and when ready to be placed back into position it usually requires two men to lift them into place and secure them properly, while with the method here illustrated, the diesetter can do all this work alone. The indexing device is not disturbed while the rolls are disengaged.

The feeding mechanism is of a good design, and is fitted up in the best possible manner, both as regards material and workmanship. In view of the fact that these machines are largely used by governments for coin cutting, a superior construction is necessary. The dies and punches in such machines must frequently be changed, often several times a day, which makes time-saving mechanisms an absolute necessity.

Another new feature of this press is the scrap-cutting device. By means of this device the scrap metal may be cut into small pieces after every stroke of the press, or, by adjusting this cutting device, the scrap can be cut into pieces 3 or 6 inches long. The government generally prefers the 6-inch lengths, claiming there is less loss than if cut at every stroke of the press. They also claim that the scrap in 6-inch lengths is much more convenient to handle and more readily handled for remelting.

The cutting capacity of this press, when the automatic roll feed and scrap cutting devices are in use, is two blanks at a stroke of the one-dollar size, three of the half-dollar size, four of the quarter-dollar size, and four of the nickel or penny sizes. Dimes could be cut five at a time. The metal, however, is usually rolled to the width of a single dollar. The dollars and half dollars are at present cut one at a time, quarters two at a time, nickels, dimes and pennies three at each stroke. As the speed of the press is 100 strokes per minute, from 100 to 300 planchets can be cut every minute, which is considered a very good production for one machine. The dies being easily removed, can readily be repaired when worn.

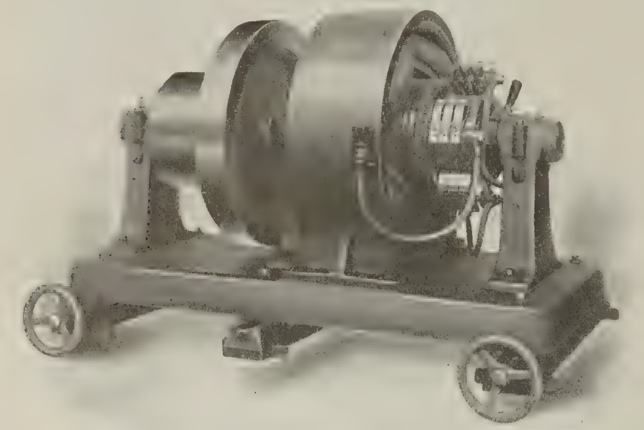
This press with feed will take metal as wide as 5 inches, although the regulation width of metal is only 1¾ inches. At the time this press was designed, rolling the metal into wider strips was considered, so as to increase the output of each machine.

By removing the roll feed and scrap cutting devices, and fitting the press with single dies, it may be used as a coin proving press.

The E. W. Bliss Co., Brooklyn, N. Y., manufacturers of these machines, inform us that governments using them find them very satisfactory.

DIRECT-CURRENT GENERATORS.

The Commercial Electric Company, Indianapolis, Ind., are manufacturing a line of direct-current generators especially designed for use in gas or gasoline engines. For this purpose, on account of the irregular impulse of the engines, it is necessary to provide a flywheel which will overcome the fluctuations of the dynamo speed and produce a steady light, which is impossible where the irregularities of the engine speed are reproduced in the armature of the dynamo. This requirement has sometimes been imperfectly met by manufacturers by placing a heavy wheel upon an extension of the armature shaft, without providing any additional support for this wheel. As standard dynamo bearings are generally not sufficiently heavy to sustain the extra weight of the flywheel, this method has given but slight satisfaction. In order to satisfactorily overcome these speed fluctuations without imposing unusual strains upon the dynamo parts, the company have designed special machines having an extra heavy shaft, which is extended to receive a heavy flywheel and which is supported by three bearings, two of which are placed close upon either side of the flywheel, where they will support its weight and receive the extra strain caused by the jerking of the dynamo belt without injurious effect upon the dynamo. These three pedestals, with the machine frame, are mounted upon a heavy iron base, which is carried upon sliding rails with handwheels and thrust screws, by means of which the belt tension can be adjusted. By this construction the overloading of the dynamo bearings or the expense of an extra countershaft for carrying the flywheel is avoided, and a substantial mechanical machine, capable of producing a steady light, is secured.


Generator and Fly-wheel for Gas Engine Connection.

MOTOR-DRIVEN BOLT CUTTER.

The accompanying cut illustrates the general design of a new motor-driven double bolt cutter recently brought out by the National Machinery Co., Tiffin, O.

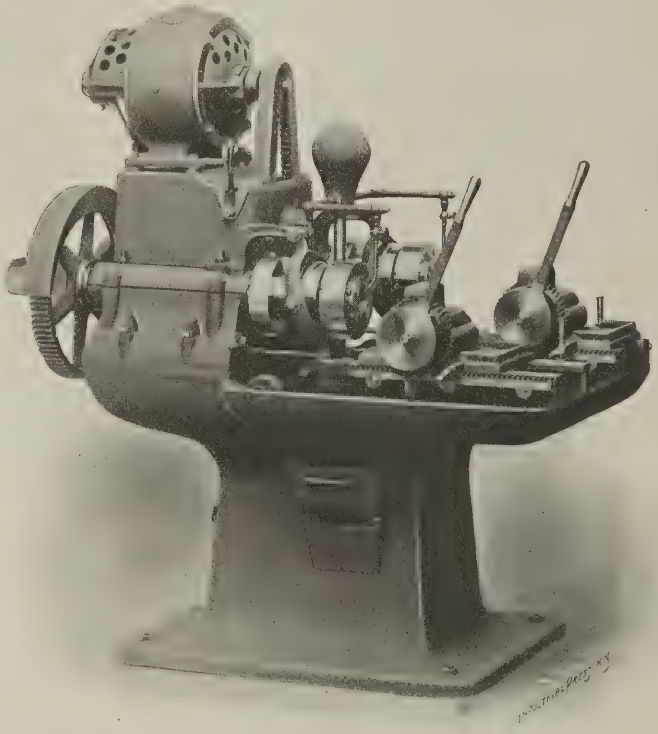
In the construction of this machine the aim was to so build it that any standard motor could be used. With this idea in view the gearing has been so designed that a great range in speed is secured in the gearing, although the gearing is neither intricate nor bulky. Any constant potential as well as multi-voltage motor can be used, as a speed variation of 40 per cent. is all that is required in the motor.

The motor is placed on top of the housing which carries the change gears, and drives the gears through a silent-running chain. All parts are protected from dirt and chips and special care has been given to the oiling system to insure perfect lubrication.

Three changes of speed are secured in the gears, and the design is such that when the machine is running on the high-speed the change gears are out of mesh. The various changes are secured by means of a latch pin and a shifting lever, shown at the side of the housing. A controller having any number of steps can be used, but with a controller having three steps, nine speeds are secured having regular even gradations. This provides proper cutting speeds for all sizes of bolts from ⅜ to 1½ inches varying by one eighth of an inch.

This machine is said to be peculiarly well adapted for motor drive, owing to the ease of operation of the cutting heads and the simplicity of the single lever vise and carriage movement, which enable the machine to be run at a high rate of speed. The machine is provided with force feed lubricating pump, and chip and oil pans, and there is an air chamber so that a constant stream of oil of considerable force is secured, insuring long life to the dies even when running at high speeds. All gears and racks are cut from solid stock. The carriages are provided with removable gibs to take up wear, and the vise jaws have removable grips made from hardened steel. There are centering devices on the vise jaws to enable the bolts to be cut to be properly centered with the dies. The die heads are of the "National" open-die type, which are automatically opened and closed by the movement of the carriages. The positive lock on these heads holds the dies rigidly in position when cutting threads, insures uniformity of production, prevents the cutting of tapering threads, and removes wear and friction from the sliding surfaces.

This machine can be furnished with power feed; and lead-screw attachments for special thread cutting. It is also furnished in sizes from ¾ inch to 2½ inches capacity.


Bolt Cutter Adapted for Motor Drive.

A NEW STEEL PULLEY.

Phillips, Townsend & Co., Philadelphia, Pa., pioneers in the wire nail industry, are putting on the market a new pressed steel pulley, the invention of Mr. Ferdinand Phillips, proprietor of the firm, and also of the Phillips Pressed Steel Pulley Works, under which title the new departure will be conducted. The pulley is characterized by an extreme originality in design and is the result of long study and experiment on the part of its inventor. We believe that a close examination of the details of the pulley will not only show the details of construction to be fundamentally new but also that the design is unusually well adapted for sustaining stresses incident to power transmission.

The hub of the pulley is made of cast iron, approaching in design the conventional hub of a split cast-iron pulley. The hub is made in halves and may be secured to the shaft by compression only, if desired; or a setscrew or keyseat may be provided. Bushings are also supplied to suit shafts of different dimensions. In these several respects, therefore, the pulley is as well adapted to the varied requirements of power transmission as is the hub of the ordinary type of cast-iron pulley.

The arms of the pulley are of triangular truss pattern. It is contended by Mr. Phillips, and we believe correctly, that pulleys with radial arms are essentially wrong. They are imitations of a cartwheel, which requires a radial post under the burdened axle as the most direct means of supporting the load; but this is different in pulleys where the strain is applied tangentially to the rim. The arms are corrugated to provide strength for transverse strains. They form a central spider which is so strongly braced as to be self-sustaining, and power is transmitted from the spider to the rim, or vice versa, in a tangential direction. The rim and the spider are each stiff enough to withstand the strains that come upon them without in any way depending upon the other member for support. A feature not appearing even upon close inspection, because of its being covered in the construction of the wheel, is a means for relieving the rivets holding the members together from the strain of power transmission. This is accomplished at the hub by countersinking the metal of the arms into the cast iron of the hub, and at the rim by means of gusset plates, designated in this case as "dowel plates." These dowel plates interlock with recesses in the central rib of the rim and the strain comes upon these plates instead of upon the rivets attaching the arms to this rib. These details are shown in Figs. 2 and 3.

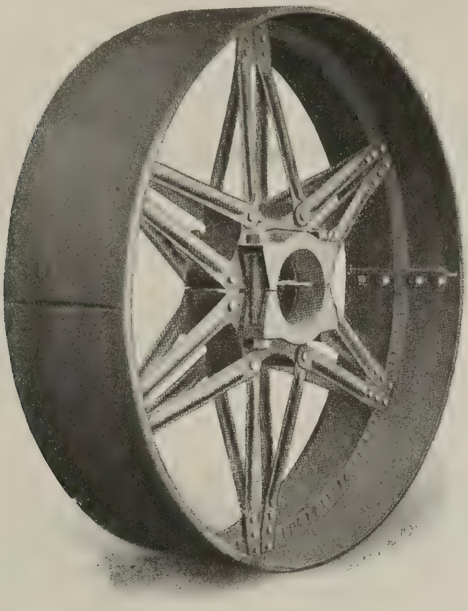


Fig. 1. Phillips Steel Pulley.

The most novel part of the pulley is the rim, which is formed of sheet metal in the shape of a T. The head of the T represents the face of the pulley. On the edge the metal is doubled over itself and finally bent in a vertical direction to the face, thereby forming the central rib. As the writer can testify, this peculiar construction, presenting a smooth, unbroken face with one central rib, has puzzled many casual observers. It is best understood by reference to Fig. 5.

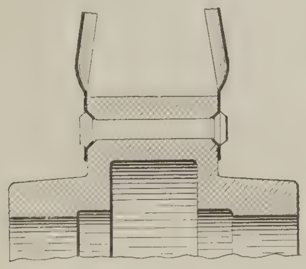
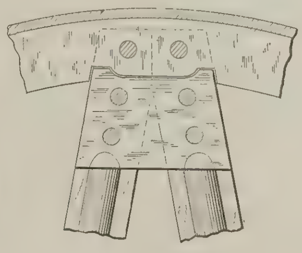


Fig. 2.



Industrial Press, N.Y.

Fig. 3.

All parting pulleys are weakest at that part of the rim where the two halves are brought together, and unless the best precaution is taken to keep the two abutting halves in perfect relation to each other, there is imminent danger to the life of belts from chafing owing to the sharp edges of the metal of the two abutting halves not meeting correctly. In the Phillips pulley the rim lugs are an integral part of the rim and extend over the whole width of the pulley, imparting to the pulley unusual strength at the joint.

Small details have likewise received proper attention. Every practical mechanic abhors the vexatious use of two wrenches in putting split pulleys together. This has been rendered unnecessary by the use of channel bars, extending over the whole row of bolts. The heads of the rim-lug bolts are bedded in these channel bars preventing them from turning when the opposite nut is screwed up.

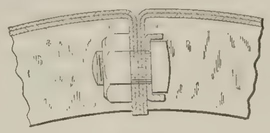
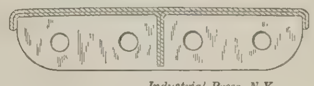


Fig. 4.



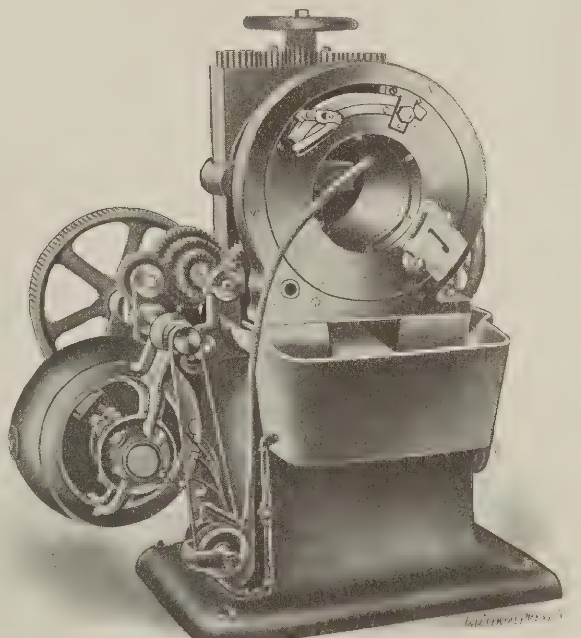
Industrial Press, N.Y.

Fig. 5

The several parts of this pulley are manufactured separately and of various gages, suitable for all exigencies and conditions and finally assembled into the finished pulley.

MERRELL PIPE-CUTTING MACHINE.

The motor-driven pipe-cutting, threading and cutting-off machine shown herewith is a combination hand and power machine mounted on a suitable base and equipped with a motor which drives through a variable speed gear mechanism, consisting of an idler pinion and a nest of gears. The illustration shows the machine without a protecting hood over the gears, but as regularly equipped a hood is provided. The rheostat is inside the base and the starting lever in a convenient location at the side of the machine. The motor is connected with a double spindle so the machine can be run either right or left. In addition to the motor drive, power may be applied either by crank or ratchet. The machines have an adjustable quick opening and closing diehead, and an improved cutting-off knife. The chasers are five in number. They can be sharpened by grinding and are readily replaced by chasers of any style or pitch of thread. The vise is self-centering and is actuated by a rack and pinion to feed the pipe into the chasers. The machine is built by the Merrell Mfg. Co., Toledo, O.



Motor-driven Pipe Cutter.

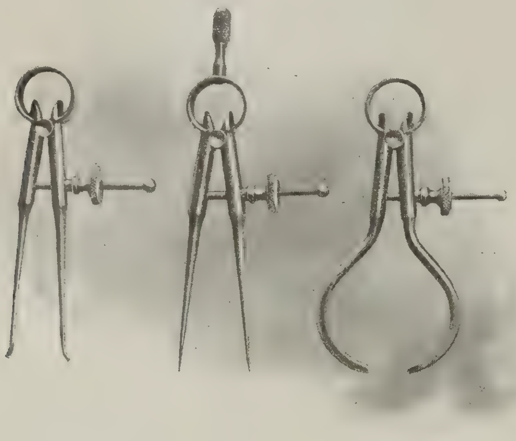
EMERY WHEEL DRESSERS.

The Diamond Saw & Stamping Works, Buffalo, N. Y., are now marketing an emery wheel dresser handle which is designed to be of great usefulness to the workman. The dresser cutters are of high-carbon steel and so tempered as to be very durable. The handle itself is made of stamped steel, is strong and light. The cutters revolve on an axle pin of hardened tool steel. These cutters are put up in sets of four with two washers, each set being neatly boxed in a small carton. The manufacturers claim for these dressers, known as the "Sterling," superior quality, economy of price and durability.

CALIPERS AND DIVIDERS.

The half-tone herewith illustrates the new line of inside and outside spring calipers and spring dividers recently placed on the market by the Brown & Sharpe Mfg. Co., Providence, R. I. The main feature of these new tools is that they have round legs instead of the flat form usually seen, and this radical departure from the well-known lines gives to the tools a great rigidity. They are especially designed to meet the demand of toolmakers and others engaged in fine work for a tool that will be rigid, light and durable.

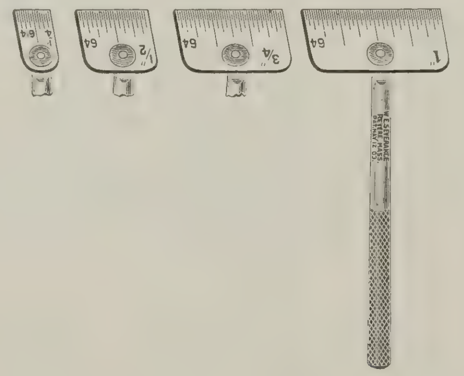
The fulcrum stud is hardened to reduce wear and prevent roughing up of the bearings. The spring is very stiff and has concave ends that fit into grooves milled in the ends of the legs. This is to insure rigidity and prevent side deflection of the legs. The legs are of steel, highly polished; the measuring points come together evenly and the screw is of fine pitch and provided with a solid nut and hardened thrust washer. These tools are manufactured in 2, 3 and 4-inch sizes.



Brown & Sharpe Tool-makers' Calipers and Dividers.

MACHINISTS' RULES.

The accompanying cut illustrates a most convenient little rule for machinists' use. It has a knurled handle which enables the user to hold it steadily in the hand, and by placing the rule at an angle it may be used in many places where it is impossible to get with the end graduation of an ordinary rule. The back corners of the scale blade are rounded, which makes it very convenient to move with the thumb while holding in the hand.



Rules with Handle Attachment.

This rule is particularly handy in setting up screw machines, in milling machines, in lathe work where there are grooves and short shoulders to be turned and where oftentimes the tailstock center is in the way when measuring small work. It is especially useful in tool and die making, and in fact, for all kinds of machine, large and small work, there are many places where these rules may be used to advantage

The rule is the product of W. E. Severance, Revere, Mass.

FLOAT BALLS.

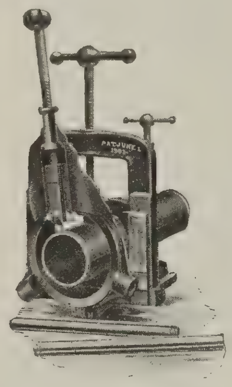
The Toledo Machine & Tool Company, Toledo, O., have recently devised a new method of forming float balls for water tanks. The balls instead of being spun into shape are made complete with dies on a Toledo open-back inclined press.

Each half of the ball is drawn in two operations and the outside edges are afterward trimmed and folded. The two halves are then clamped together by means of a closing die. In this closing die a very ingenious device is used which closes the halves of the ball so tightly together that very little solder is necessary to make the ball air tight.

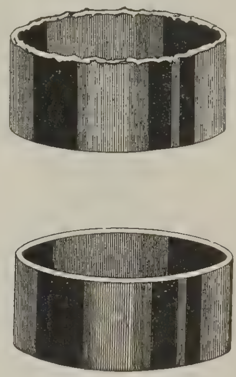
The floats are produced in a much neater and smoother manner by this method than by spinning them into shape and are produced at from 50 to 60 per cent. less labor cost with the dies than is possible with the old method. Another great advantage is that no great expense or outlay is necessary to put in an equipment for doing this class of work.

PIPE CUTTER.

The Wilson pipe cutter, made by the Curtis & Wilson Machine Company (Goldsborough & Smith, 72-76 Trinity Place, New York, sole agents), is designed for cutting cast-iron pipe, and the tool is held in such a manner as to provide suitable rake and clearance so that a clean cut is made, leaving the pipe without a burr. There is no tendency of the machine to crush the pipe, the tool acting like a lathe tool. The pipe can be threaded immediately after being cut, without being removed from the machine, inasmuch as the vise can be employed like an ordinary pipe vise. The operation of the cutter will be clear from the illustration.



Improved Cutter for Cast Iron Pipe.



Pipe Cut with Ordinary and with Improved Cutter.

* * *

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

The Sprague Electric Co., New York. Bulletin No. 219 of round type motors, direct-current. This pamphlet is profusely illustrated.

The Diamond Saw & Stamping Works, Buffalo, N. Y. Booklet illustrating the hacksaw blades and frames made by this company. Sizes and prices are given.

The Lewis Foundry & Machine Co., Pittsburg, Pa. Catalogue No. 14 of shears, roll lathes, engines, hydraulic machinery and miscellaneous machinery. Handsome cuts illustrate the various machines.

The Shelby Steel Tube Co., Pittsburg, Pa. Advertising card illustrating this company's exhibit at St. Louis. This is a sort of booth built, we judge, entirely of Shelby steel tubing.

The Magnolia Metal Co., New York. Illustrated booklet of the "Magnolia" metal manufactured. It contains testimonials regarding this product, a price list, some useful tables, etc.

The Curtis & Wilson Machine Co. Leaflet pertaining to the Wilson pipe cutter for the cutting of castiron pipe. Messrs. Goldsborough & Smith, 72-76 Trinity Place, New York, are sole agents.

F. W. Braun & Co., Los Angeles, Cal. Pamphlet entitled "Annealing Hardening, Tempering and Casehardening," with information concerning the company's portable forge and tempering furnace, and some useful hints regarding the operations of annealing, hardening, etc.

The Charles G. Smith Co., Pittsburg, Pa. "Album of Machine Tool Illustrations," being a collection of illustrations of the products of prominent manufacturers in the machine tool field whom this company represent.

The Northern Electrical Mfg. Co., Madison, Wis. Leaflet No. 130 calling attention to the advantages of the "Northern" spherical motors for driving purposes. Illustrations are given of these motors driving a buzz saw, a swing cut-off saw, a woodworking lathe, etc.

The Rand Drill Co., 128 Broadway, New York. Pamphlet illustrating and describing some of the company's standard types of air and gas compressors. Complete information may be had by writing for their catalogues.

The Coburn Trolley Track Mfg. Co., Holyoke, Mass. Catalogue of the Coburn trolley track, showing them in operation in various places. These are equipped some with self-locking block, others with electric hoist, etc.

The Heald Machine Co., Worcester, Mass. Illustrated catalogue of the "American" drill grinders, belt and motor driven. This company also manufacture the "Heald" wet cutter and grinder, the "American" center grinder, and the "Heald" piston ring grinder.

The Grant Gear Works, Boston, Mass. 1904 catalogue and price list of gears. Herein are listed brass gears, brass racks and ratchets, internal gears, worms and worm gears, sprockets and chains, iron gears, etc., etc. Valuable tables and charts, relative to gearing also appear.

The Chester B. Albree Iron Works, Allegheny, Pa. New riveter catalogue No. 6, presenting the latest forms of the Pittsburg riveting machines, with descriptive matter relative to same. A large number of useful tables concerning rivets and riveting are also to be found in this catalogue.

The Rand Drill Co., 128 Broadway, New York. Novel mailing card in the form of the new "Imperial" hammer. The address is

MACHINERY.

August, 1904.

THE ZOELLY STEAM TURBINE.

A steam turbine now attaining a prominent place abroad is the Zoelly turbine which has been developed and is now manufactured by Escher, Wyss & Co., Zurich, Switzerland, the famous manufacturers of hydraulic turbines, water-wheel governors, etc. A number of large German firms, of which the Krupps are one, are reported also to have formed a syndicate for the manufacture and sale of this turbine on a large scale.

The Zoelly turbine is of the impulse type and its general arrangement is evident from the half-tone illustration, Fig. 1, and the line drawing, Fig. 2, almost without explanation. The turbine is divided into two parts, encased separately, and placed far enough apart to permit a bearing to be located between them for supporting the shaft at the center. In Fig. 1 the top of the casing of the low-pressure compartment is lifted, exposing the wheel blades to view, and in Fig. 2 the same compartment is shown in section. The construction of the high-pressure section is entirely similar to the low-pressure, except that the steam passages have less area. This is because the steam expands as it flows through the turbine; and the steam passages, which are comparatively small at the high-pressure end, must gradually increase in area to provide for the increased specific volume of the steam.

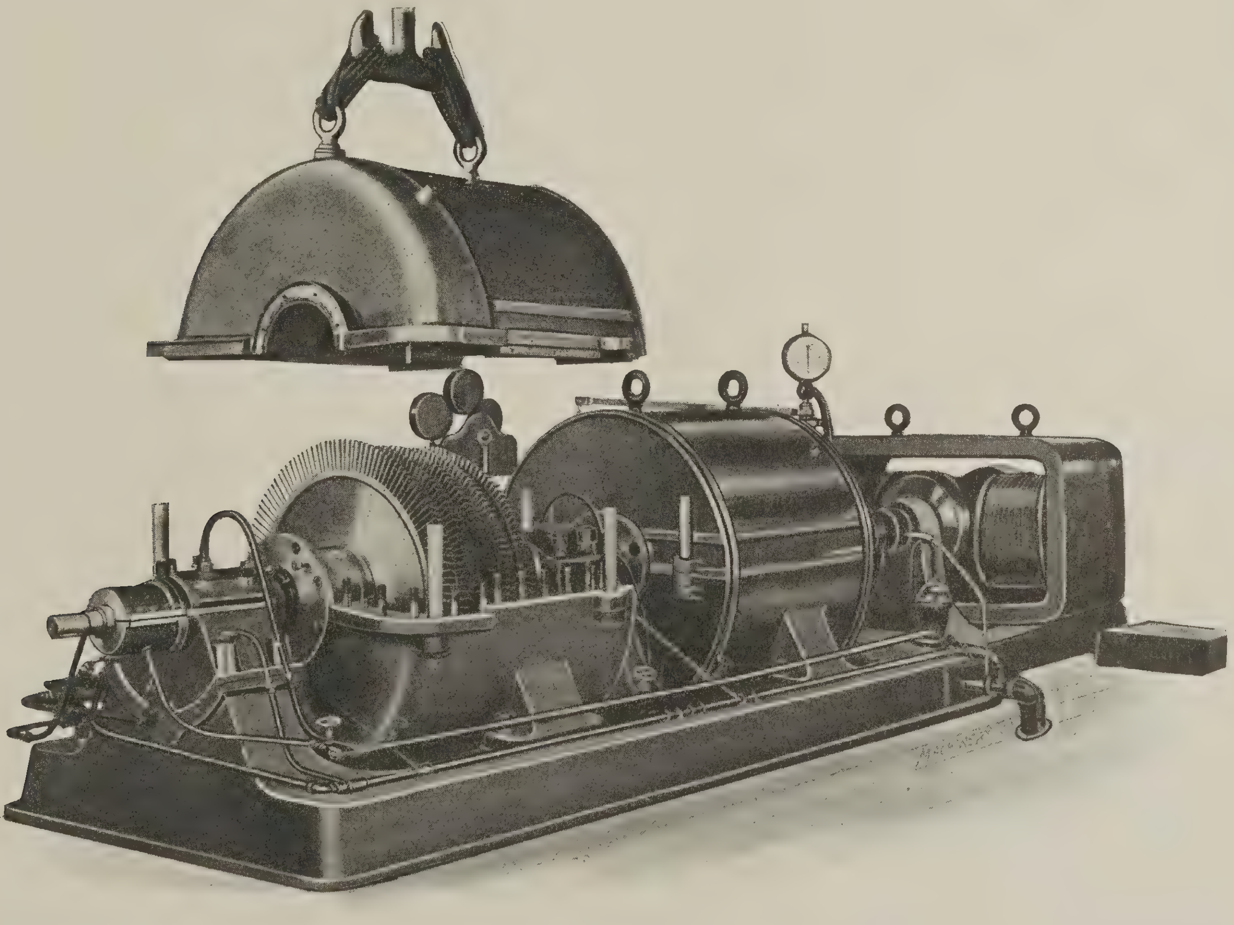


Fig. 1. Zoelly Steam Turbine, built by Escher, Wyss & Co., Zurich, Switzerland.

In this turbine there are ten rotating wheels constructed in the form of circular disks, attached to the same shaft and carrying curved blades on their peripheries. For each wheel there is a set of guide vanes for directing the steam against the rotating blades. These guide vanes give the steam the proper direction of flow and allow it to expand a certain amount as it passes through the guide passages, their function being the same as that of the steam nozzle in the De Laval turbine. Each wheel rotates in a chamber by itself, the walls of which are formed by the disks to which the guide vanes are attached. The steam enters at *A*, Fig. 2, and passes through a throttle valve operated by the governor, to the high-pressure compartment. Here it flows through the first set of guide passages, and impinges against the blades of the first wheel. The guide passages permit the steam to expand to the somewhat lower pressure of the first chamber and thus partially convert its potential energy to kinetic energy, which is mainly given up to the rotating wheel, since the steam leaves the wheel at a low velocity. The steam now passes through the passages of the second guide disk, expands to a lower pressure and is directed against the blades of the second rotating wheel in the second compartment, where it again gives up its kinetic energy. When the last step is reached in the low-pressure compartment the steam finally exhausts, either into a condenser or into the air.

At the beginning of the high-pressure section, the guide vanes occupy only a part of the periphery of the turbine, but toward the end of the low-pressure part they extend around the whole circumference. It will be noted in Fig. 3 that the passages through the guide vanes have parallel sides; that is, the walls do not diverge as in the nozzles of the De Laval turbine. This construction is based on the well-known fact that steam will expand and convert its available heat energy into kinetic energy, or the energy of motion, by flowing through a nozzle having straight, parallel sides, provided the final pressure is not less than six-tenths of the initial pressure; whereas, if the final pressure is less than this, the walls of the nozzle must diverge in order to fully expand the steam.

In the Zoelly turbine the expansion occurs in successive steps and the pressure does not drop sufficiently at any one step to make guide passages with diverging sides necessary.

It will be noted further, from Figs. 2 and 3 that the passages through the wheel blades have their inner sides inclined, producing channels of gradually increasing area. This is not, however, to allow for expansion. In this turbine, as in others of the impulse type, the pressure of the steam does not change in passing through the rotating wheel. The pressure is uniform throughout the chamber in which the wheel turns, making a drop in pressure in passing through the wheel impossible, and hence the only effect of the sloping sides of the wheel passages is to cause the steam to flow smoothly, without eddy currents, into the next guide passages, which are of larger area than the ones preceding. The conditions under which the steam flows through the wheel are entirely different from those which influence the flow through the guide vanes, for the latter have a higher pressure on one side than on the other.

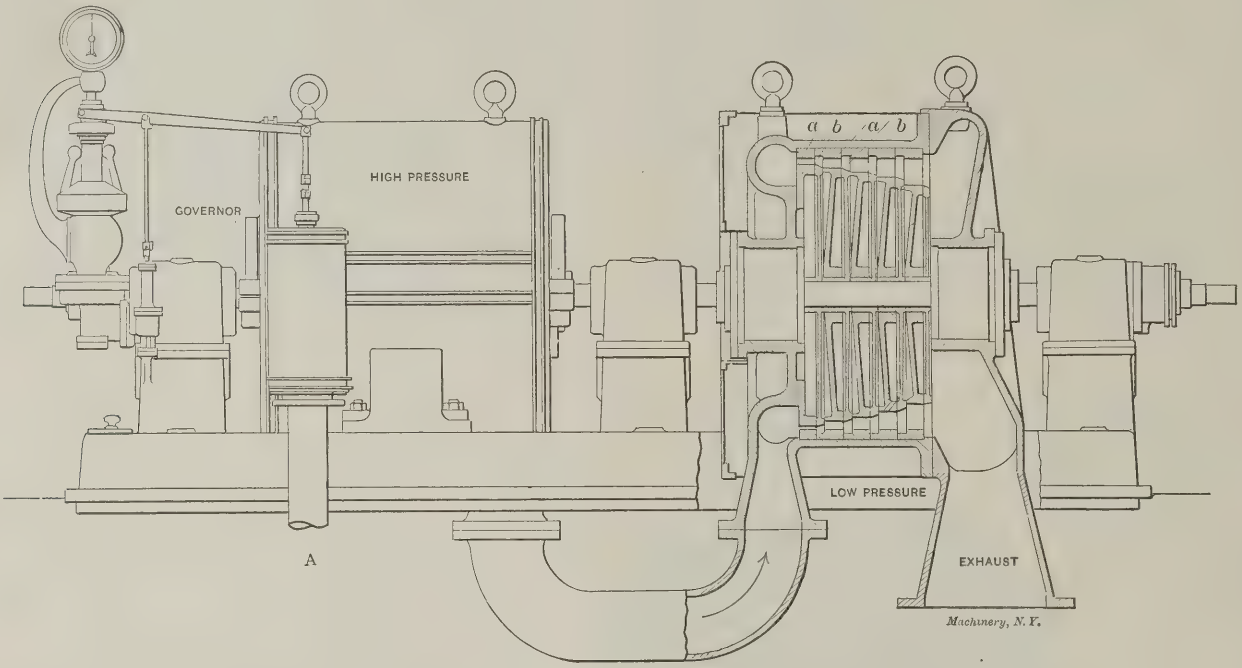


Fig. 2. View showing Section of Low-pressure Turbine; a, a, are Guide Vanes and b, b, Wheel Vanes.

The fact that each wheel is running in a medium of uniform pressure eliminates entirely any end thrust of the shaft and reduces the leakage through the clearance spaces between the wheel and guides to little or nothing.

Enlarged sections of the wheels and guides are shown in Fig. 3. The principal difference between the Zoelly turbine and others of similar type, such as the Rateau, which has already been described in these columns, lies in the construction of the details of the turbine wheels. These are designed to permit a high rotative speed without straining the material, which makes it possible to reduce the number of steps used in the turbine to a minimum. The wheels are forged of one piece, including the hub, from Siemens-Martin steel and a T-slot is machined out of the circumference of the disk to hold the blades and their distance pieces as shown in Fig. 3. One side of the slot is closed by a wrought iron ring, *r*, which is riveted to the disk. The blades are radial, and made of nickel steel, highly polished, which resists erosive action very effectually. The cross section of the blades decreases as the radius increases, thus reducing the stresses due to centrifugal force to a minimum. The blades and distance pieces are milled by special machinery.

The disks which hold the guide vanes and separate the turbine into compartments, are bored out to receive the hubs of the turbine wheels, as shown in Fig. 3. As there is a higher pressure on one side of each disk than on the other, it must be steam tight to prevent leakage and strong enough to prevent deflection. The only place where leakage can occur is at the center, where the bore of the hub must be loose enough for a running fit over the hub of the wheel. Annular grooves are turned in the bore to reduce this leakage, on the same plan that grooves are sometimes turned in the surface of a pump plunger for the same purpose. The guide disks are divided on a diametral line, with their top halves bolted to the top of the casing and their lower halves to the base so that the top casing and guides can be lifted off, exposing the wheels, as in Fig. 1. The joints of these disks are ground to a close fit, to prevent leakage.

The casings for the high- and low-pressure parts of the turbine are mounted on the bed plate by brackets placed midway between their ends to prevent distortion from expansion, due to the heat of the steam. There are also large clearance spaces between the guide vanes and wheel blades, made possible by the fact that there is but small tendency to leak at these points, as explained above. This reduces the likelihood of the blades being displaced sufficiently, through the heat of the steam, to cause rubbing when the turbine is running.

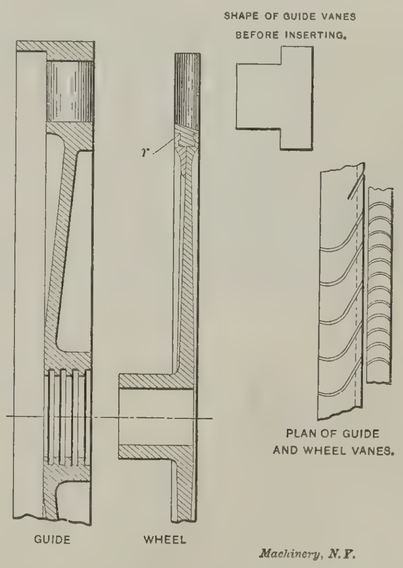

SHAPE OF GUIDE VANES BEFORE INSERTING.
r
PLAN OF GUIDE AND WHEEL VANES.
GUIDE
WHEEL
Machinery, N.Y.

Fig. 3. Details of Guides and Wheels.

In Fig. 4 is a detail drawing of the governor, which controls the turbine by throttling the steam. A centrifugal governor acts on a relay valve, *m*, and connects one side or the other to pipes *a* and *b*; *a* being a pipe leading from a reservoir full of a liquid, such as oil or water, under pressure produced by a rotary pump; and *b* a return leading to the suction well of the pump. The two pipes *e* and *f* connect each end of the valve to the cylinder *g*, which is located on top of the main throttle valve. The moving part of this valve is attached to

TESTS ON A ZOELLY STEAM TURBINE OF FIVE HUNDRED BRAKE HORSE POWER.

	Dry Saturated Steam.								Superheated Steam.		
1. Test number	1	2	3	4	5	6	7	8	9	10	11
2. Net power developed in K.W.	363.06	387.65	334.51	240.1	182.22	80.13	......	......	391.66	389.6	390.4
3. Revolutions per minute	2967	2967	2977	2983	2984	2995	2995	3000	2972	2973	2968
4. Pressure in steam pipe, lbs. sq. inch, abs	158.7	158.7	155.	156.6	156.	157.	157.	159.1	182.2	186.7	160.1
5. Superheat, degrees Fahr.	......	......	......	......	......	......	......	......	135.	153.	109.
6. Pressure, lbs. sq. inch, abs ...... After passing through governor throttle valve.	143.6	143.6	128.4	98.4	77.8	43.7	17.3	10.6	138.2	138.2	139.4
7. Superheat, degrees Fahr. ..... After passing through governor throttle valve.	......	......	......	......	......	......	39.4	53.	102.	107.	101.
8. Pressure in exhaust pipe, lbs. sq. inch. Steam was saturated	1.02	1.03	0.965	0.934	0.940	0.741	0.725	0.731	0.928	0.944	0.984
9. Vacuum in condenser, inches of mercury	......	28.5	28.5	28.4	28.3	28.6	28.6	28.5	28.7	28.7	28.7
10. Steam consumption, lbs. per hour	7903	8327	7425	5778	4683	2650	1025	651	7454	7335	7730
11. Steam consumption per kilowatt hour	21.76	21.45	22.19	24.06	25.70	33.07	......	......	19.05	18.80	19.80

the same valve stem as the piston *h*, in the cylinder *g*. If the load on the turbine is decreased, the resulting increase in speed raises the governor lever *n*, and valve *m* makes a direct connection between *a* and *f* and *e* and *b*. The liquid, entering cylinder *g*, forces piston *h* down, which closes throttle valve *k* a corresponding amount, reducing the pressure of the entering steam. The valve stem is prolonged and attached to the end of lever *n*, and hence the downward movement of the throttle valve moves the relay valve *m* back to its original position. During this return movement of the valve *m* the lever *n* pivots about its left hand end; while, when the lever was originally moved by the governor, it pivoted about its right hand end. Lever *n* is thus what is called a floating lever, the fulcrum of which is shifted from one end to the other, according to the conditions. When valve *m* has been returned to its original position, no further movement of the throttle valve can occur until the speed of the turbine changes again.

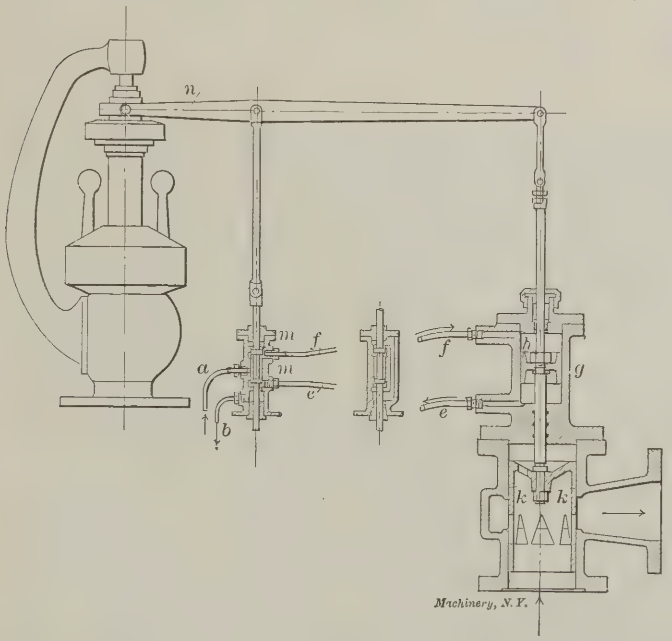
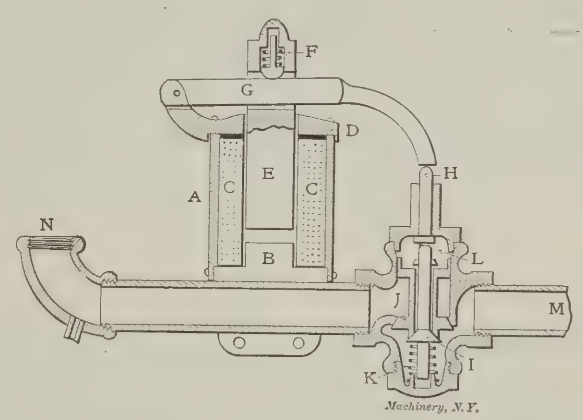


Fig. 4. Arrangement of Governor and Throttle Valve.

A steam turbine of the type described was built at the Zurich works in 1903. The turbine was later tested by Dr. Stodola, professor at the Zurich Polytechnikum and Mr. Wagner of the Zurich Electricity Works. An abstract of the tabulated results is given herewith, with the various units converted into the English system. Every effort was made to provide perfectly dry steam for the tests with saturated steam. The turbine was tested at constant steam pressure but with a gradually decreasing load, regulation of the speed being effected by throttling the steam as it entered the turbine. The superheating indicated in columns 7 and 8, line 7, is due to the steam being throttled by the governor. The last line of the first six columns shows the increase in steam consumption with the reduction in load and the horse power developed in each test is indicated in the second line. The turbine was running unloaded in tests 7 and 8. By comparing the tests with superheated steam with the saturated steam tests it will be seen that there is a gain in efficiency of about one per cent. for every 9 degrees of superheat, Fahr.

* * *

The Electrical Appliance Co., of Cincinnati, Ohio, are making an ingenious device for operating steam whistles. By its use the whistle may be operated from any point in the works, no matter how far distant, and by connecting with suitable clock-work, it may be automatically blown at stated times.



Magnet and Valve for Operating Steam Whistles.

In the illustration *A* is an iron shell for protecting the magnet winding, *B* the iron base of magnet, *C* the magnet winding, *D* iron cap for magnet, which is also utilized to afford a hinge for the lever *G*, which is actuated by the iron plunger *E*. *H* is a sliding pin which rests upon the stem of the small valve *I*. *J* is a larger valve, and *K* a spring for closing both valves. *L* is an expansion chamber. Steam is supplied through the pipe *M* and the whistle is attached at *N*.

The operation is as follows: The electrical circuit having been closed by pressing a button or automatically by clockwork, *B* becomes a magnet and draws down the plunger *E*, thus depressing lever *G*. This moves pin *H* downward and opens the small valve *I*, with the result that steam is admitted to the chamber *L*, where it aids in opening the larger valve *J*. When the electrical current is broken, the spring *K* causes the valves to close and the various parts return to their first position.

* * *

Very pure iron can be produced by the electrolytic process, the purity being in excess of 99.9 per cent. The impurity consists of hydrogen but this has a most remarkable effect on the product, making it nearly as hard and brittle as glass. Electrolytic iron containing occluded hydrogen can be broken up into grains or can be reduced to a powder in a mortar. But by heating to a white heat the hydrogen is driven off and it becomes soft, having much of the malleability and toughness exhibited by Swedish iron. Pure iron has a very high melting temperature, being about the same as that of platinum, or about 3,200 degrees F.

THE STEAM TURBINE IN A MUNICIPAL STATION—CENTRAL STATION OF THE CITY OF JACKSONVILLE.

The rapid progress made in the rebuilding of the city of Jacksonville made necessary the consideration of extensions to the city electric plant to satisfactorily meet increasing demands for electric light and power.

As the available space was limited and the cost of foundations for reciprocating engines would have been a large item, owing to the character of the soil, the merits of the steam turbine as a prime mover, were given careful consideration.

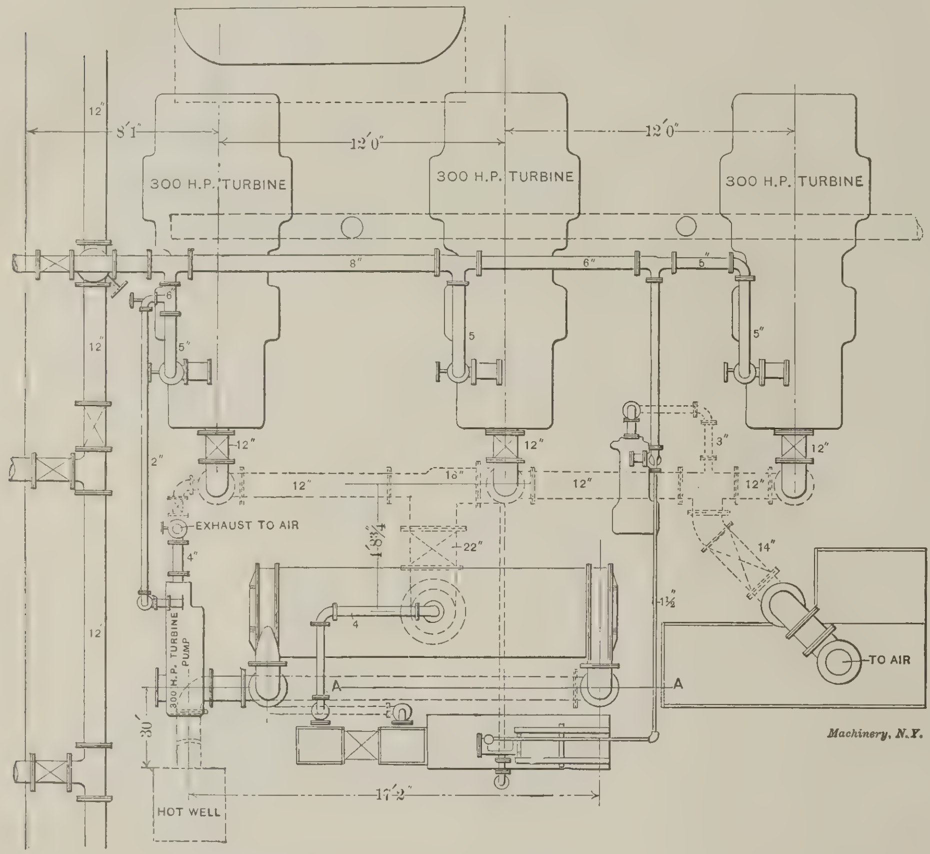


Fig. 1. Plan of Part of Station where Turbines are Located.

It was finally decided to place two 300-horse power De Laval steam turbines, direct connected to two 200-kilowatt Bullock three-phase, 2,300-volt twin alternators designed for 7,200 alternations per minute. Two 350-horse power Babcock & Wilcox boilers, Alberger condenser and other necessary accessories were installed. It was later decided to place an additional 300-horse power De Laval steam turbine, direct connected to a 200-kilowatt, 500-volt, direct-current generator. The entire contract was assumed and executed by the D'Olier Engineering Company, Philadelphia.

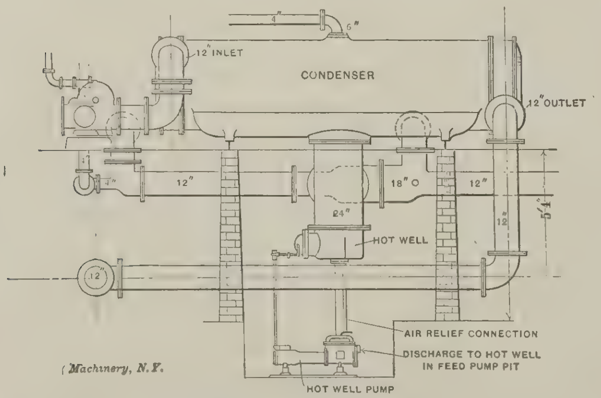


Fig. 2. Elevation of Condenser and Hot Well; Section on line A A above.

The plant is located near the center of the city, the lines extending about one mile north, one and one-half miles to the east, two miles to the southwest and one-half mile to the west. Alternating current is furnished for lighting and direct current is furnished over an area of about two square miles for elevator motors and other power service. The general layout of the additional plant installed is shown in Fig. 1.

The two Babcock & Wilcox boilers are operated under natural draught, a steel stack 100 feet high and 60 inches in diameter being used. The boilers are connected to the main steam header which also connects to the old boiler plant. A working pressure of 200 pounds is maintained and each boiler is equipped with a Babcock & Wilcox superheater, which produces steam superheated about 100 degrees Fahrenheit when boilers are operated at their rating. The high pressure and superheat combined are especially applicable for steam turbine service.

Fig. 3 is a view of the turbines from the steam end. The old plant will be noted in the background. The small pipes leading to the end bearings of the turbines supply water to water jackets for cooling the bearings. The high-speed bearings are all lubricated from a central oil tank which feeds the manifold sight-feed lubricator on each turbine. The steam turbine exciter is shown between the two alternators. Fig. 4 shows the steam turbine pump used to supply circulating water; also the steam condenser and vacuum pump in the foreground. It will be noted that steam turbines are used exclusively as prime movers in this part of the plant excepting for the vacuum pump.

The Alberger condenser used is guaranteed to be capable of condensing fifteen thousand pounds of steam per hour and to maintain a vacuum of 28 inches with barometer at 30 inches; and under these conditions the plant is operated on a most efficient basis.

The alternating-current switchboard is constructed of Tennessee marble, consisting of three panels supported on angle iron frame. Each generator panel is provided with three ammeters, voltmeter, rheostat, combined oil switch and circuit breaker and necessary synchronizing device.

The complete plant, with the new additions consists of the following apparatus: Four Babcock & Wilcox boilers of 350 horse power each and one Caldwell boiler of 350 horse power; one Filer-Stowell Corliss cross-compound engine of 750 horse power, and two Hamilton Corliss tandem compound engines of 350 horse power each; four General Electric monocyclic generators, two of 150 and 200 kilowatts respectively, and two 250 kilowatts each; three No. 11 Brush arc dynamos with a capacity each of 125 lights of 2,000 candlepower; one direct-current 150-kilowatt, 500-volt generator; two 300-horse power, 200-kilowatt De Laval turbine alternating-current generators and one 300-horse power, 200-kilowatt De Laval turbine direct-current generator with condensers and auxiliaries.

The plant is owned by the city of Jacksonville and is under the supervision of the Board of Trustees for the Water Works and Improvement Bonds.

* * *

So many nut-locks have been patented that it is difficult to say what is new in this line. What is supposed to be a new idea, however, was recently patented in Great Britain. The nut is not faced off squarely on its base but, instead, is provided with an arched or angular base, the point of the arch or angle coinciding with a medial line through the base. Two saw cuts are made in opposite sides of the nut, at right angles to the hole, until they nearly meet. When the nut is screwed up tightly, the arched base flattens, closing the saw cuts at their outer edges and, consequently, pinching the threads. The trouble with this and similar inventions in the nut-lock line is that they work fully as effectually in preventing the nut being set up tightly as in stopping its working loose. A simple and effective nut-lock is another nut.

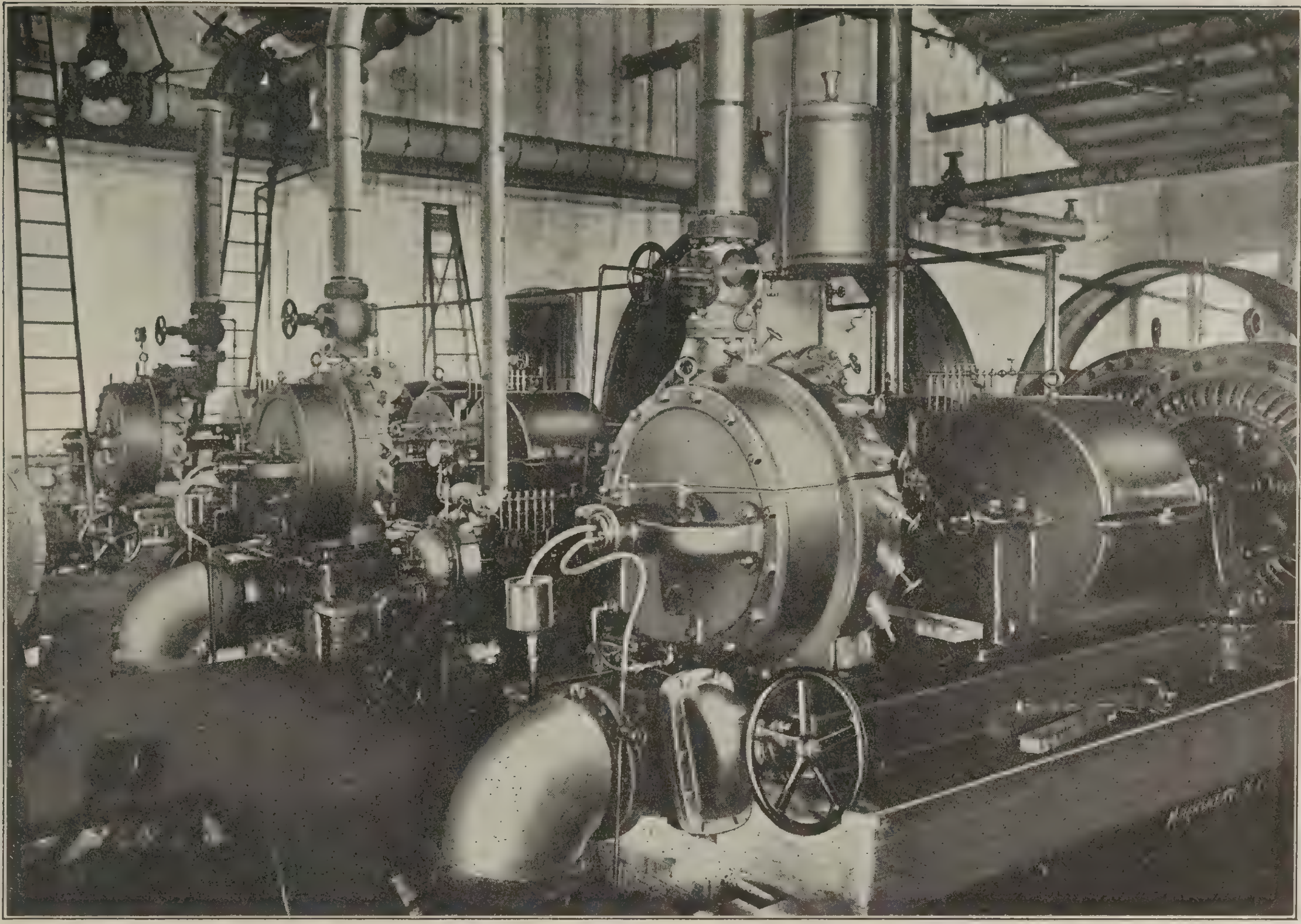


Fig. 3. View of De Laval Turbines in the Central Station of the City of Jacksonville.

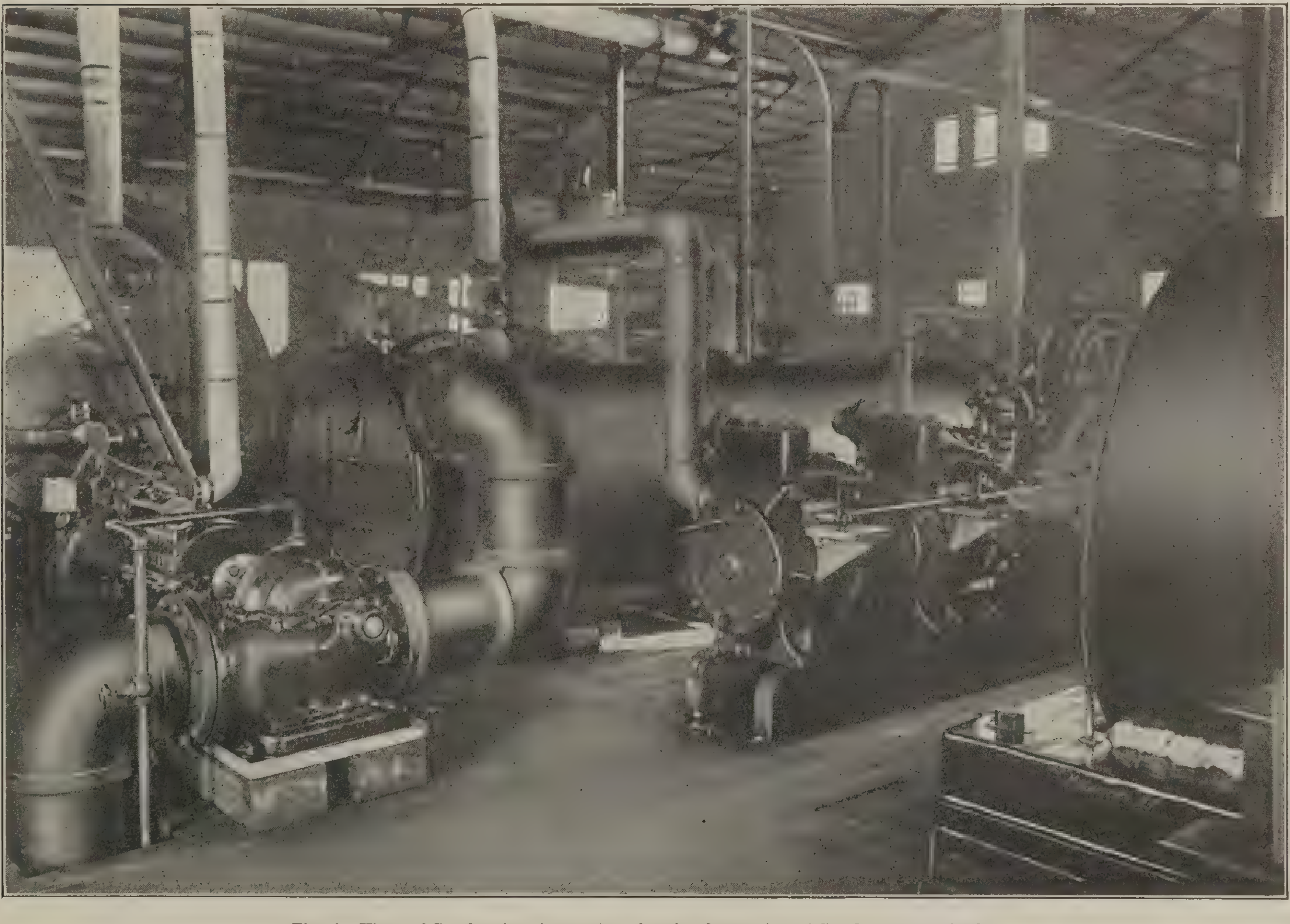


Fig. 4. View of Condensing Apparatus showing large size of Condenser required.

VARIABLE SPEED MOTORS.—5.

THE BULLOCK THREE-WIRE SYSTEM.

WM. BAXTER, JR.

As we have already explained in previous articles of this series, the size of motor required to do a given work depends upon the amount of speed variation; the greater the variation the larger the motor. The size of the motor, however, is also dependent upon the way in which the speed variation is obtained; for example, to obtain a variation of, say, four to one by field regulation alone will require a considerably larger motor than would be necessary if the voltage acting on the armature were also varied. It is for this reason that three- and four-wire systems have come into use. If by means of these systems the size of the motor could not be reduced, they would not be used, as the simple field regulation is less complicated and expensive; but owing to the reduction in the size of the motors, it is found that the saving made in this direction more than offsets the greater cost and complication of the multi-voltage systems.

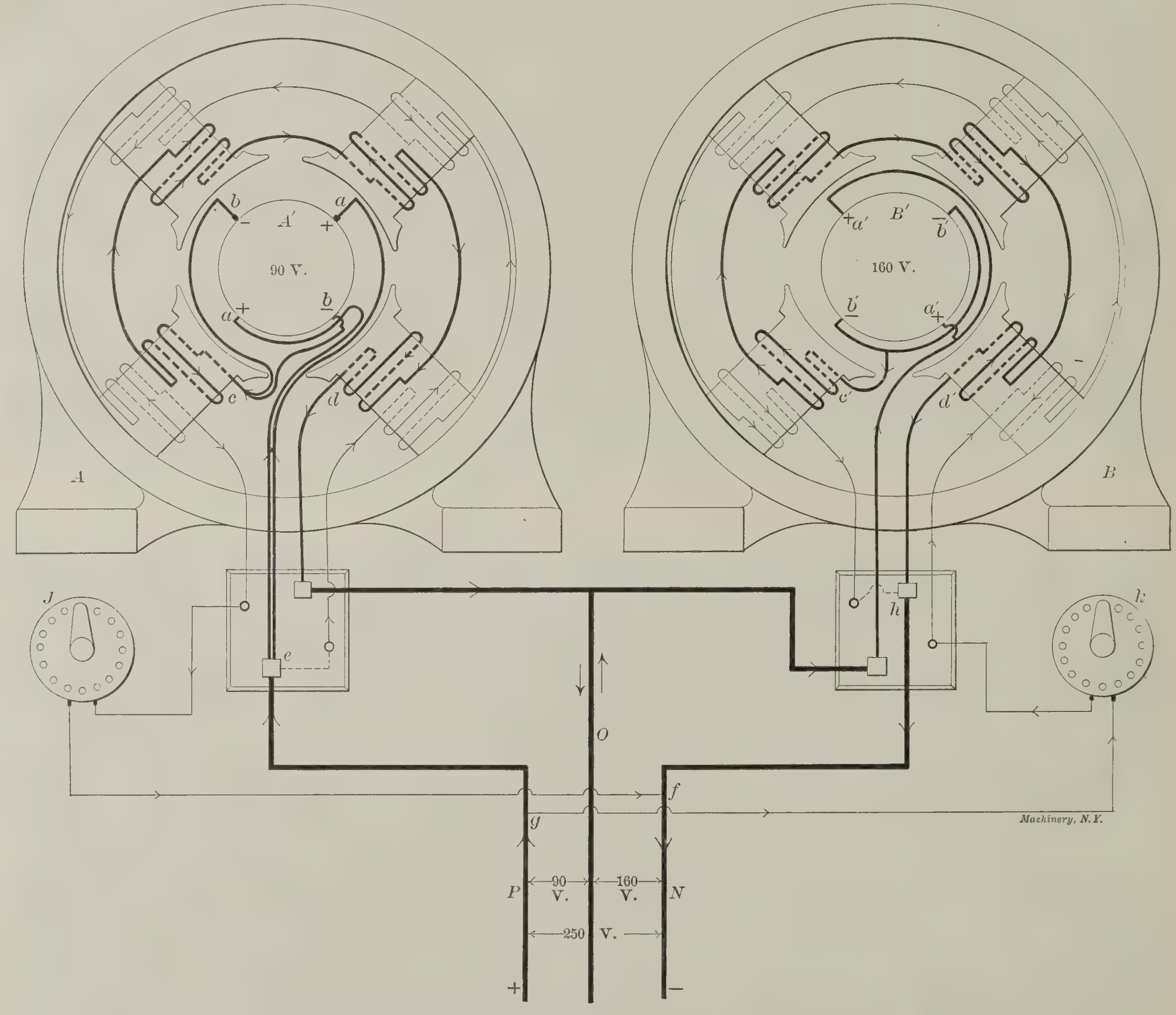


Fig. 7. Diagram showing Balancer for the Three-wire System of the Bullock Electric Mfg. Company.

The four-wire system renders it possible to obtain a range of speed variation of 6 or 7 to 1, without using unreasonably large motors; but experience has shown that in most cases, a range of 4 or 5 to 1 is all that is required, and this can be readily obtained by means of the three-wire system in connection with field regulation, the motors remaining about the same size as for the four-wire system with wider speed variation.

The Bullock Company uses a three-wire system for all cases where the speed range required is not much more than 5 to 1. In this system the voltages between the middle and the side wires are not equal, and as a result three different E. M. F.'s are obtained. Thus with a maximum E. M. F. of 250 volts, the voltages between the center and the side wires are 90 and 160, which makes the lowest E. M. F. about 36 per cent. of the highest; the actual ratio being about 2.8 to 1. It is easy to make motors that can give a speed variation of 2 to 1, without being unreasonably large; hence, with such motors and a three-wire system, with the voltages above named, the speed variation will be 5.6 to 1.

The Balancer for the Three-wire System.

The balancer used by the Bullock Company for the three-wire system, as well as that for the four-wire, is provided with compound wound fields; and these, by acting differentially on the machine that runs as a motor, and cumulatively on the machine that acts as a generator, control the voltages so as to maintain that acting on the motor constant, or practically so, for all changes in the strength of armature current. The arrangement of the field coils can be readily understood from the diagram, Fig. 7, in which *A B* represent the two machines that constitute the balancer, *A′ B′* being their armatures. The lines *P O N* constitute the distributing mains, with which the motors are connected, the leads from the generator being connected with *P* and *N*. The arrow heads show the direction of the currents when the machines are both acting as motors, but when either one of them acts as a generator the direction of the current through its armature and series field coils is reversed. As will be seen, the main current after passing through the armature *A′* enters the series field coils at *c*, and comes out at *d*. It then passes to machine *B* and after traversing the armature *B′* enters the series field coils at *c′*, and passes out at *d′*.

The shunt field circuit of machine *A* starts from line *P* at *e*, and runs to line *N* at *f*. By looking at the arrow heads on the shunt and series field coils of this machine, it will be seen that the currents in the two run in opposite directions, so that the series coils act in opposition to the shunt coils. The shunt field circuit of machine *B*, branches from *P* at *g*, and enters *N* at *h*, and in this machine, as will be seen by looking at the arrow heads on the fields, the currents in the shunt and series coils flow in opposite directions, so that the series coils act in opposition to the shunt, the same as in machine *A*. At *J* a field rheostat is provided to regulate the shunt field current of machine *A*, and at *k* is another field rheostat to regulate the shunt field current of machine *B*.

From the foregoing it will be seen that when both machines, *A* and *B*, act as motors, the action of the series field coils is differential. When either one of the machines acts as a generator, the direction of the current through its armature and series field coils is reversed, and then the series coils assist the shunt coils, that is the action is cumulative. The way in which this reversal of the current in the series field coils acts to keep the voltage constant can be more clearly explained by the aid of the simple diagram, Fig. 8.

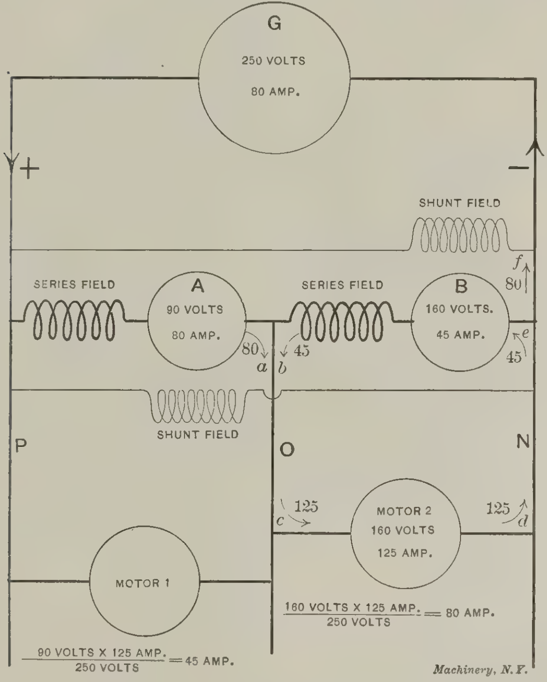


Fig. 8.

Principle of Operation of the Balancer.

In Fig. 8, *G* represents the main generator, and the circles *A B* are the armatures of the two machines that constitute the balancer. The shunt coils magnetize the fields of the machines, and the series field coils demagnetize them to a certain extent, that is, when the current flows through the armatures from *P* toward *N*. The velocity at which an armature will rotate depends upon the strength of the field. The stronger the field the lower the speed. The E. M. F. developed in an armature depends upon the strength of the field and the velocity of rotation. The stronger the field the higher the E. M. F.; and the higher the velocity, the higher the E. M. F. In other words, increase in field strength, and increase in speed, both act to increase the E. M. F. of a generator armature. The E. M. F. developed by a generator armature is not all available outside the machine; a portion of it is expended in overcoming the armature resistance, and this portion increases with the strength of the current, so that the stronger the current the lower the net E. M. F. In a motor a portion of the E. M. F. of the current that passes through the armature is absorbed in overcoming the resistance of the wire, the balance of the E. M. F. is balanced by the counter E. M. F. developed in the motor armature, so that the speed of the latter must be just enough to develop this E. M. F., and no more. If the current passing through the motor armature is increased, the portion of the E. M. F. absorbed by the resistance of the wire will be increased, and as a result the velocity of the armature will be reduced.

Keeping these facts in mind it can be seen that if the armatures *A B* were acted upon by the shunt field coils only, the one acting as a motor would decrease in velocity if the current increased, and the one acting as a generator would give a reduced net voltage if the current increased. The reduction would be due not only to the greater loss of voltage within the armature, but also to the reduction in speed; for it must be kept in mind that the armature that acts as a motor drives the other one. When the two machines are provided with series field coils, if the current through the armature of the one that is acting as a motor increases, the differential action of its series coils will also increase, thus weakening the field and causing the armature speed to increase. The other machine, acting as a generator, will have its field increased, because the direction of the current through the series coils will be reversed, and this increase in field strength, together with the increased velocity, will result in an increase in the voltage of the current generated.

By properly proportioning the series field coils, the increase in speed as well as the increase in the field strength of the machine that is acting as a generator can be made just sufficient to off-set the increased loss of voltage in overcoming the resistance in its armature, so that the net E. M. F. will remain constant.

Comparative Action of Shunt and Compound Wound Balancer.

In Fig. 8 if a motor is connected in the circuit in the position marked "Motor 2," the balancer machine *A* will act as a motor, and *B* will act as a generator. Suppose the balancer is shunt wound, that is, that the series field coils are removed, then the strength of the fields of the two machines will remain constant regardless of what the current through Motor 2 may be. Let us suppose the current through Motor 2 is 12½ amperes; then there will be 8 amperes flowing through *A* and this machine acting as a motor will drive *B* and cause it to generate a current of 4½ amperes. These figures would be correct if we made no allowances for losses within the armatures of *A* and *B*. The current of 8 amperes flowing through *A* would cause it to revolve at a velocity that would develop a counter E. M. F. of very nearly 90 volts, and this velocity would be sufficient to enable *B* to develop a voltage of a little more than 160, so that deducting the portion absorbed by the armature resistance, there would be a net E. M. F. of 160 volts to act on Motor 2. Now if the current through Motor 2 is increased to 125 amperes that through *A* will become 80 amperes and that through *B* will be 45 amperes. With these currents, *A* will run considerably slower, and as a result the E. M. F. developed by *B* will be reduced, while the portion thereof that will be absorbed by the armature resistance will be ten times as great as before, so that the net voltage acting on Motor 2 will be considerably below 160.

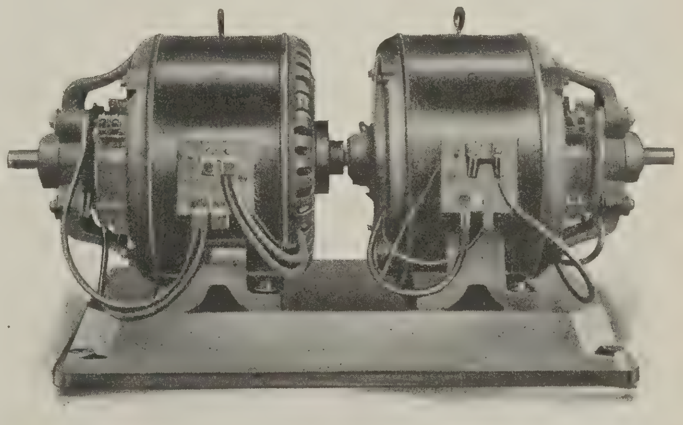


Fig. 9. Bullock Three-wire Balancer.

If the two balancer machines are provided with series coils, the action will be considerably modified, because the current flowing through the coil of *A* will act in opposition to the shunt field coil, while the current flowing through the series coil of *B* will act with the shunt field coil. Owing to this difference, the field of *A* will be weakened and, therefore, the armature will run faster, while the field of *B* will be strengthened and this increase in field strength, together with the higher speed will cause the machine to develop a higher voltage. If the current passing through Motor 2 is 12½ amperes, the speed and the E. M. F. developed in *B* will not be much different from what it is shown above to be with the simple shunt field; but if the current is increased to 125 amperes the speed of *A* will be materially increased, and the field of *B* will become much stronger, so that the voltage developed by *B* will be sufficient to overcome the increased loss within its armature and still leave a net E. M. F. to act on Motor 2, equal to that obtained with the weaker current. By properly proportioning the series coils each machine can be made to develop a net voltage that is practically the same for all strengths of current passing through the motor, whether the latter is connected in the position of Motor 2 or Motor 1.

Size of Balancer Required for a Given Service.

In Fig. 8 it will be noticed that the current passing through armature *A* is a trifle less than two-thirds of that passing through Motor 2. If the motor were connected between lines *P* and *O*, the current through *A* would also be 80 amperes. In the first case, *A* would draw its current from the generator *G* and acting as a motor would drive *B*, causing it to generate a current of 45 amperes. In the second case, *A* would act as a generator and would deliver a current of 80 amperes, and *B* would act as a motor and draw 45 amperes from generator *G*. In both cases it will be seen that the maximum current passing through the balancer is about two-thirds of that passing through the motor.

If Motor 1 and Motor 2 are both in service, and both take the same current, no current will pass through the balancer except the small amount necessary to keep the armatures rotating at their normal velocity, and this would be only a few amperes. From this it can be seen that the balancer must be of sufficient size to furnish a current equal to the difference between that required by the motors connected on opposite sides of the middle wire. If only one motor is in use, the current capacity of the low-voltage armature of the balancer can be two-thirds of that of the motor. If a number of motors are in use, the current capacity of the low-voltage armature need not be much in excess of that of the largest motor, because the load on one side of the center wire *O* is not likely to differ from that on the other side by an amount greater than this. The greater the number of motors in use, the smaller the size of the balancer relative to the total capacity of the motors.

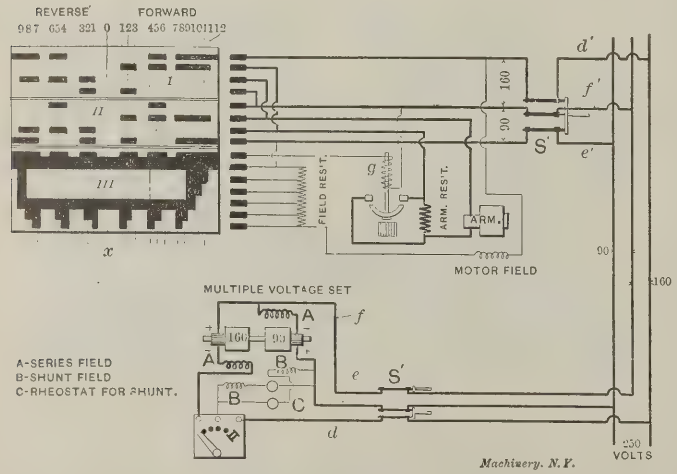


Fig. 10. Controller used with Three-wire System.

The design of the three-wire balancer of the Bullock Company is shown in Fig. 9.

The Controller for the Bullock Three-wire System.

The controller used with the three-wire system is shown, diagrammatically, in Fig. 10, in which the lower part represents the balancer and the upper part the controller, the motor and the connections between the two. This diagram is so simple that it will need but a slight explanation. The drums marked I, II, III, shown in the upper left-hand corner, are mounted on the controller cylinder, and as in the four-wire controller are metallic casings surrounding the cylinder, the dark portions being raised so as to make contact with the row of stationary contacts which are shown at the right side of the drums. The true position of these stationary contacts when the controller is in the stop position, is along the center vertical line *x*. The two upper drums are for the purpose of connecting the armature terminals of the motor with the lines *d'*, *e'*, *f'*, so as to change the connections from the 90 to the 160 and finally to the 250 volt lines. The controller gives 12 speeds forward, and 9 when reversed. On the first speed the motor armature is connected with the 90-volt lines, on the 4th speed it is connected with the 160-volt lines and on the 7th speed it is connected with the 250-volt mains. The lower drum is for the purpose of cutting the field resistance in and out of the circuit. The field resistance is all cut out on the first, fourth and seventh steps. On the second step one section of the field resistance is cut in; on the third step two sections are cut in. On the fifth and sixth steps one and two sections, respectively, are cut in. From the eighth to the twelfth steps all the sections of the field resistance are cut into the field circuit, one after the other.

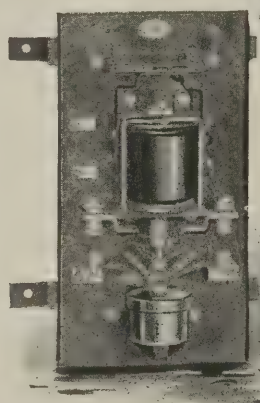


Fig. 11.

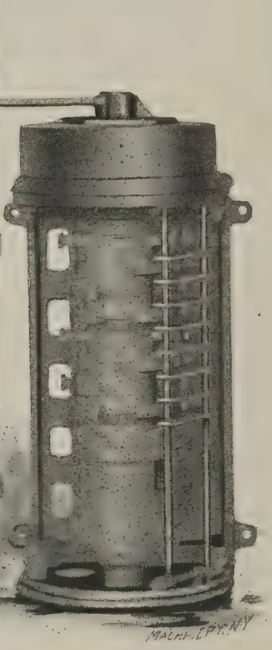


Fig. 12.

The motor is started with a resistance in the armature circuit, and this is cut out automatically by an electro-magnetic switch *g*, which is provided with a retarding device that can be adjusted so as to close the switch in whatever interval of time may be necessary. This switch is shown in the half-tone, Fig 11. The controller proper is shown in Fig. 12.

* * *

A certain industrious correspondent living near Boston runs a manuscript mill that must work day and night, judging from the number of his articles one sees in many of the reputable technical journals. While his articles are well gotten up and neatly typewritten, they are in most cases absolutely worthless, being fakes of the most transparent order. They all have certain characteristic earmarks, and many of them tell of weird ways and methods of making repairs on any machine, including automobiles, electric motors, telephones, machines, etc. A favorite graft since the Spanish-American war has been alleged letters from an ex-soldier telling of the mechanical devices used by the Filipinos, many of which are undoubtedly without parallel on earth or any other place. Within the past six months two of the leading electrical journals have published his articles, one of which tells of the alleged uses of rawhide in the Far East. We are solemnly told that rawhide washers on electrical devices are a failure except when thin metal washers are used on top. Why in the name of common sense does any one want to use rawhide washers on electrical devices or any other devices One cannot help admiring the versatility of this gentleman. His talent is certainly of no mean order, although prostituted in the hoaxing of editors. We have found his work in electrical, mechanical, automobile, sporting, literary, and even in theological journals, in which latter case he posed as a "reverend."

MODEL PLANT OF THE NEW BRITAIN MACHINE COMPANY.

As a model example of the mill type of construction, applied to machine shop use, we show in this number several views and drawings of the recently completed works of the New Britain Machine Company, New Britain, Conn. This plant, conveniently located with respect to freight and passenger stations and local trolley lines, is of brick, with four stories and basement. The multi-storied construction became necessary owing to the cost of land in the location above, convenient to other shops and central with respect to a local jobbing trade. Under similar circumstances the plan of the works would be available for any general machine shop employing from 100 to 200 hands on medium and light work, using 38,000 square feet floor area. Being of the mill type, however, its various features can be applied to similar buildings, whether larger or smaller, since the main difference between a large and small building of this character lies in its length and the number of its floors.

Apart from being an excellent example of mill construction, the plant is of interest because of its equipment and arrangement. One of the chief products of the New Britain Machine Company is a line of shop furniture, consisting of metal racks, lathe pans, stationary and portable shelves, etc., all of which are conducive to the convenient handling and orderly storing of stock, small tools and machine parts. This "furniture" is much in evidence in this plant, as a matter of course,

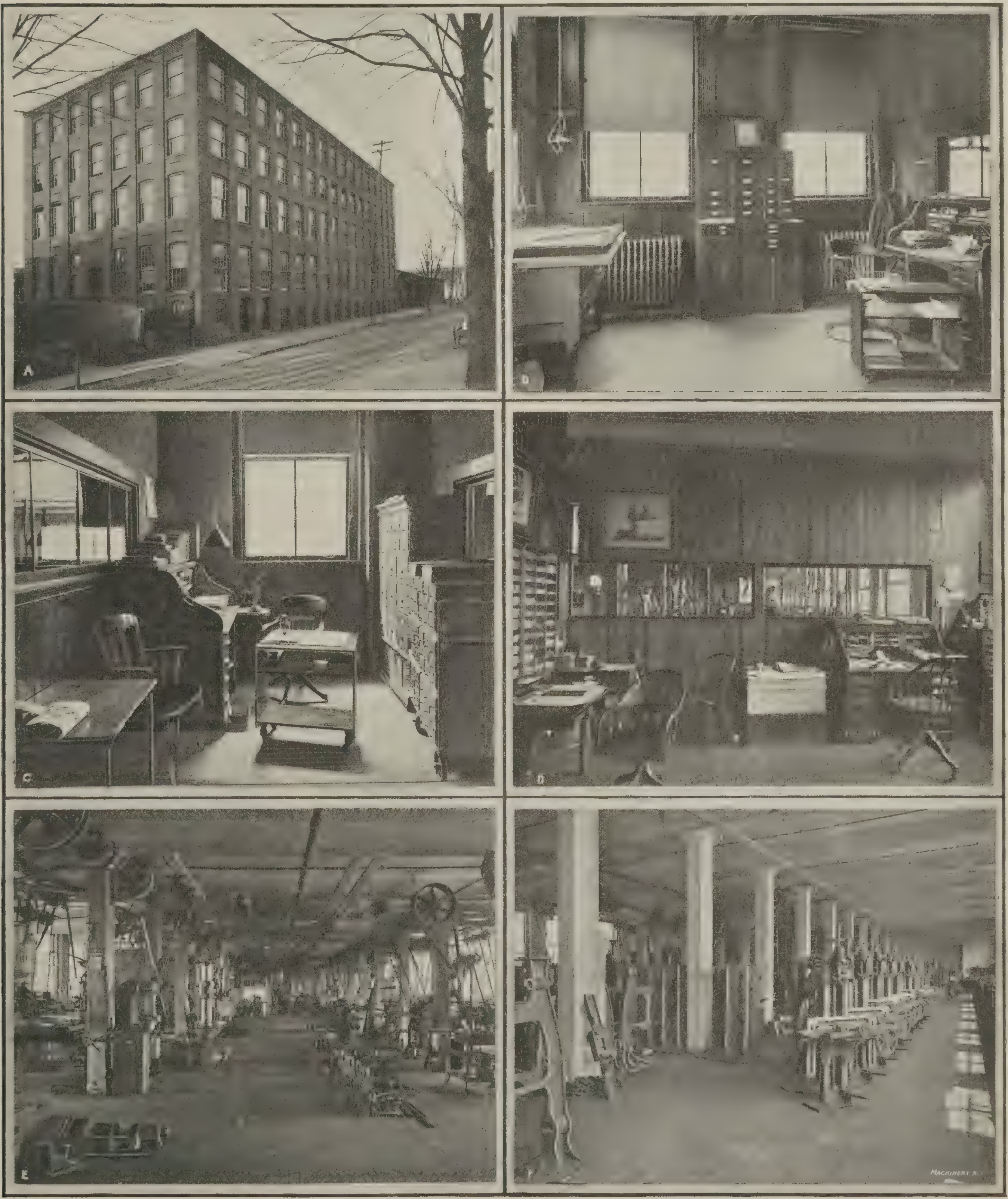


FIG. 1. GENERAL VIEWS OF THE NEW BRITAIN MACHINE COMPANY'S PLANT.

A. Building.
C. Sales Manager's Office.
E. View of Second Floor.
B. Secretary's Office.
D. Superintendent's Office.
F. Assembling Room.

adding to its attractiveness; but it comprises only one of many mechanical niceties that have been introduced and which appeal strongly to the systematically inclined.

Mr. R. S. Brown is secretary and mechanical engineer of the New Britain Machine Co., and we are indebted to him for the following description, which explains many interesting details about the plant and its equipment.

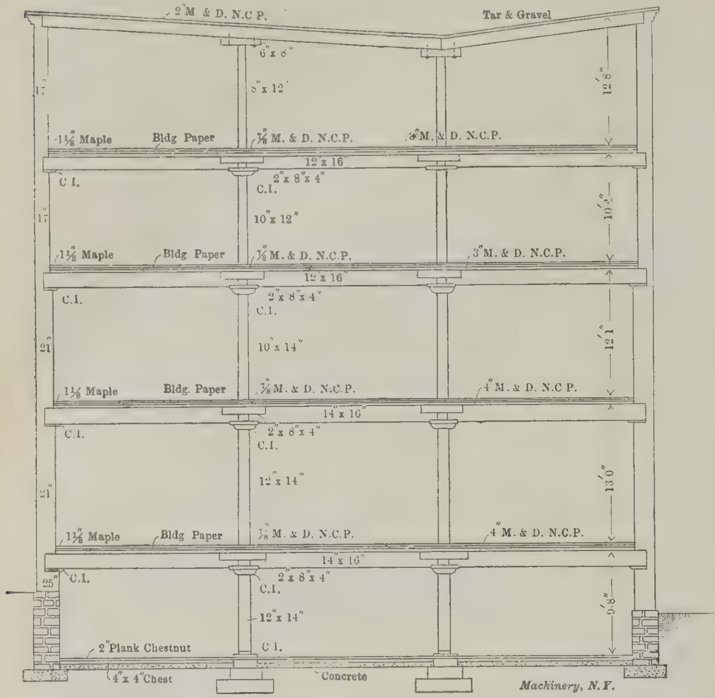


Fig 2. Cross-section of the Building.

Outside, a pleasing effect is given to the building by the use of round-cornered brick on all external corners; this is thought to help a little, also, in letting in better light by the corners of the pilasters. These pilasters are carried straight up to the roof, and the diminution of thickness of wall from bottom to top, as indicated in the sectional sketch, Fig. 2, gives increased floor space on the upper floors.

At the front of the building, which is the left-hand end in Fig. 1, are located the offices, drawing rooms and also a fireproof vault which extends up from the basement through three stories. The offices are separated from the manufacturing part of the building by a brick fire wall. The introduction of this wall did not cost as much as was saved by the lighter timbering possible under the offices, as against the cost of standard heavy mill construction for this part of the structure. The effect of the wall, of course, is to practically insulate the offices from the jar and noise of the factory.

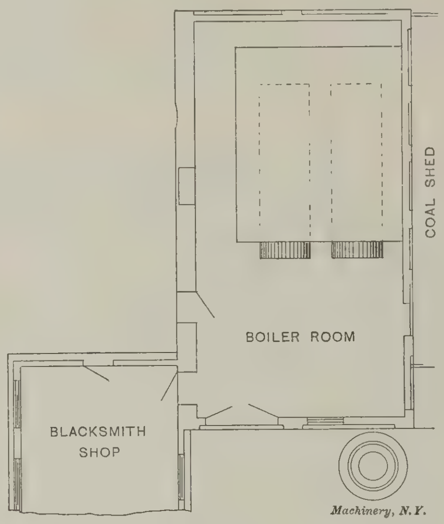


Fig. 4.

The opposite or east end of the building has been sheathed temporarily with planking and iron, and it is planned to extend the building at this end when the growth of the business demands it. When this is done the elevator, outside stairs, the closets, the power, tool room, etc., will all be at the middle of the completed building, and thus involve the least amount of travel for each operative.

In Fig. 3 is a plan view of the basement, where are located the wash rooms, racks for clothing, and where the engine testing and assembling of different lines of machinery are carried on. The workmen enter the building through the door near the west end, at the left. They have the advantage of a large wash room and individual hooks, etc., for clothes. Passing through a turnstile, as shown, the time clock is

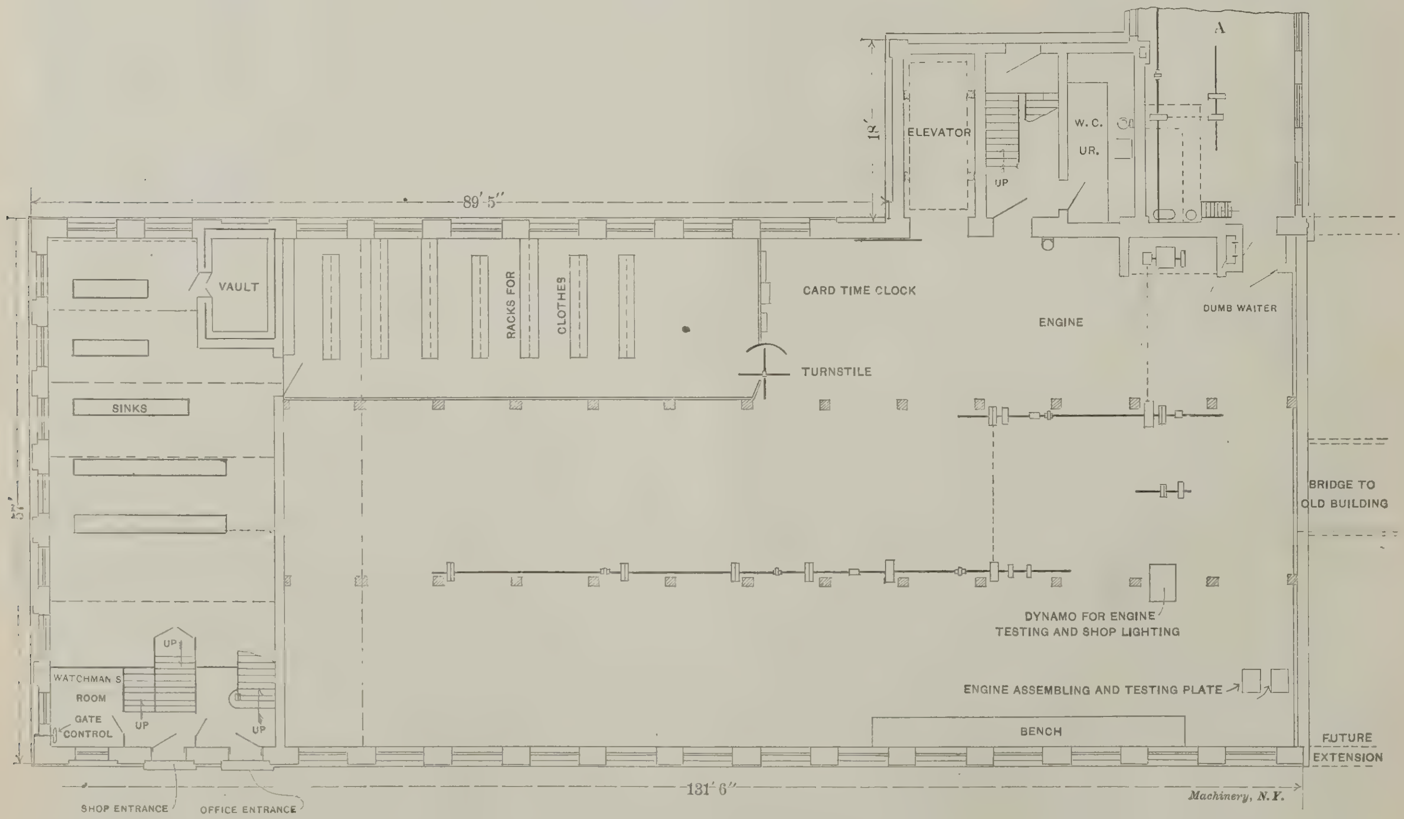


Fig. 3. Plan of Basement. Workmen's Entrance at the Left, where are located the Wash Rooms.

reached. The turnstile can be locked against backward rotation and the coat and hat room thus made inviolate. By changing the lock the turnstile is left free to rotate in the opposite direction, but prevents unauthorized entrance into the building during the noon hour or at other times.

At the top in Fig. 3 will be noted the location of the stairs and elevator, which latter is of unusual proportions, 16 by 6 feet, with a capacity of 3 tons. This size was chosen with the idea of carrying lumber, shafting, steel, etc., in commercial lengths when lying flat on the car; and although somewhat large for rapid traveling, it is found that by counterbalancing on both the car and the drum, it works very easily. The outside door of the elevator being level with the ground greatly facilitates loading and unloading, and is particularly handy in the case of automobiles needing repairs.

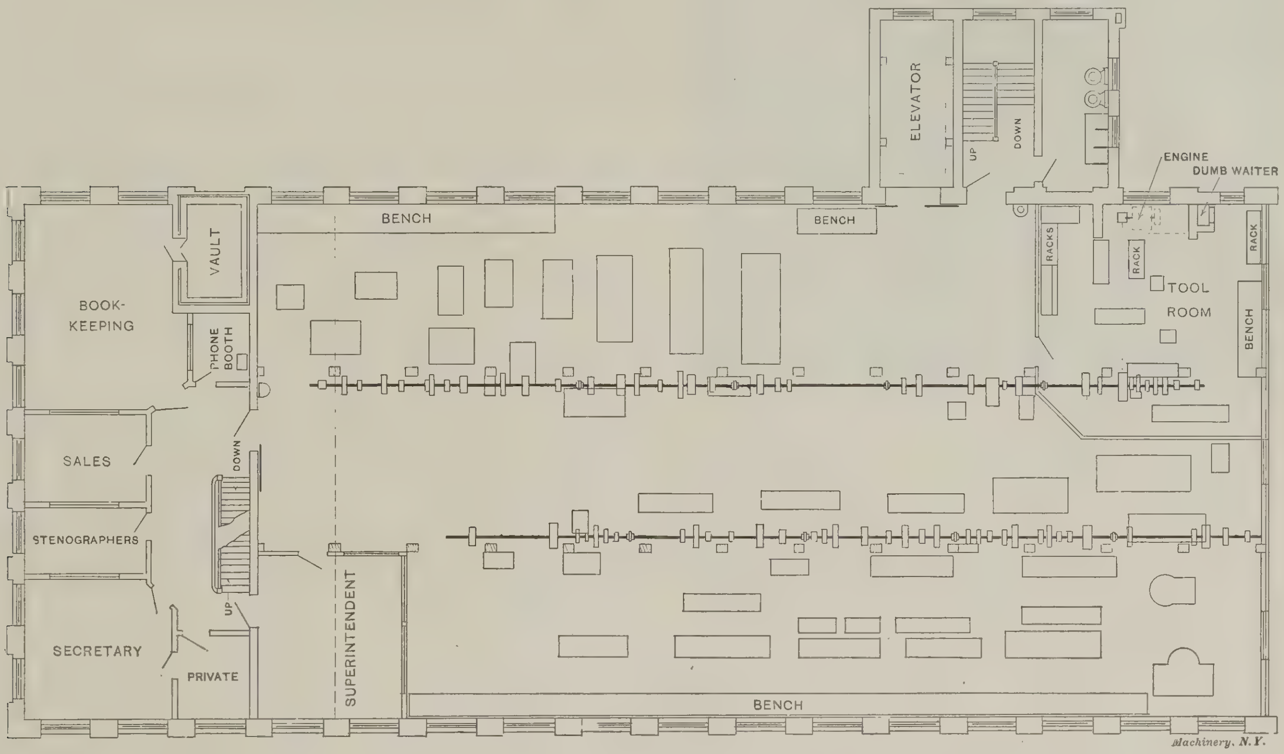


Fig 5. Plan of Second Floor, where are located the Business Offices.

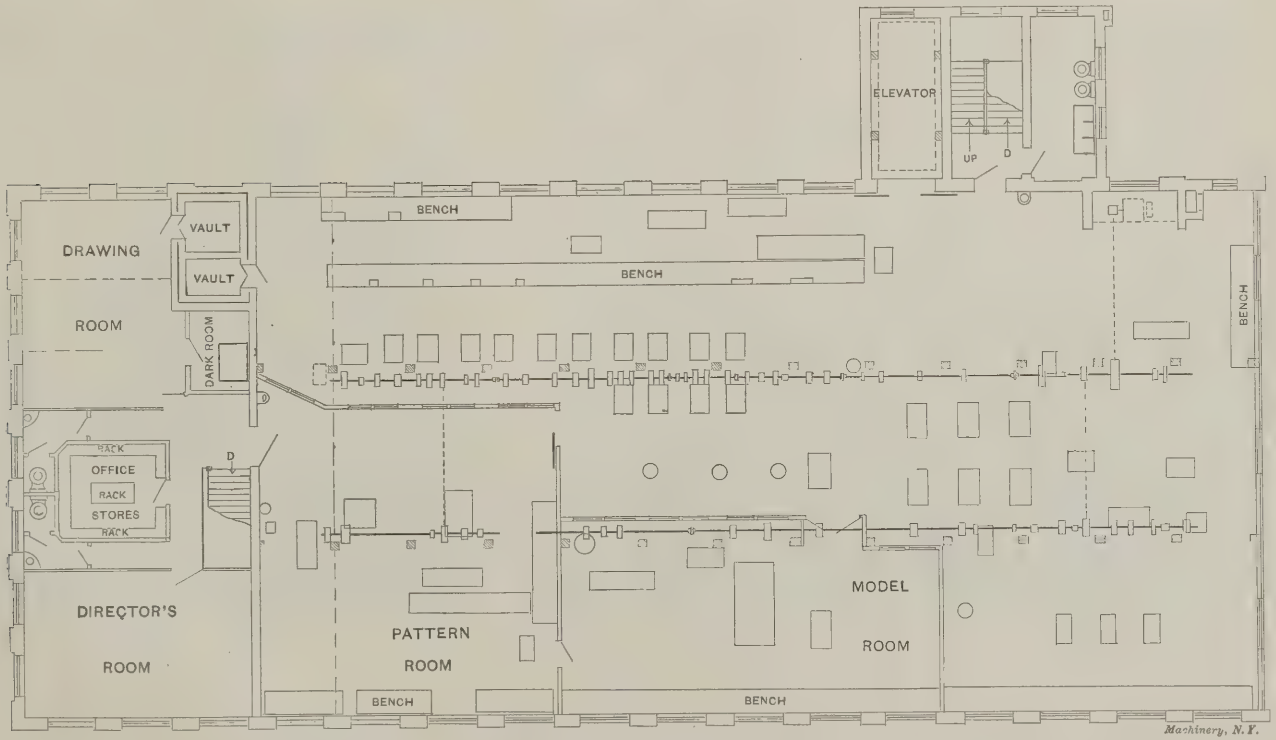


Fig. 6. Plan of Third Floor.

The blacksmith shop, indicated in Fig. 4, connects with the basement at point *A*, Fig. 3. A dumbwaiter, shown in the upper right-hand corner of Fig. 3, runs from the entrance of the blacksmith shop to each floor above and is largely used for conveying tools to be dressed or light work to and from the smiths. Speaking tubes are beside it, and the intention has been to provide all conveniences for the workmen right on the floor where employed, so there is no occasion for traveling to other floors.

At the left of the dumbwaiter in Fig. 3 is shown the location of the engine which furnishes power for the basement. This company manufacture the Case vertical steam engine, and have placed one of their machines, of 25 horse power, on each floor, to supply the motive power for that floor. This plan lends itself to the individual needs of each department with all the flexibility of motor drive and the possibilities of change in the speed in any department by a slight change in the governor of the engine. All belt holes in the floor are thus avoided. For supporting this engine two piers or wing

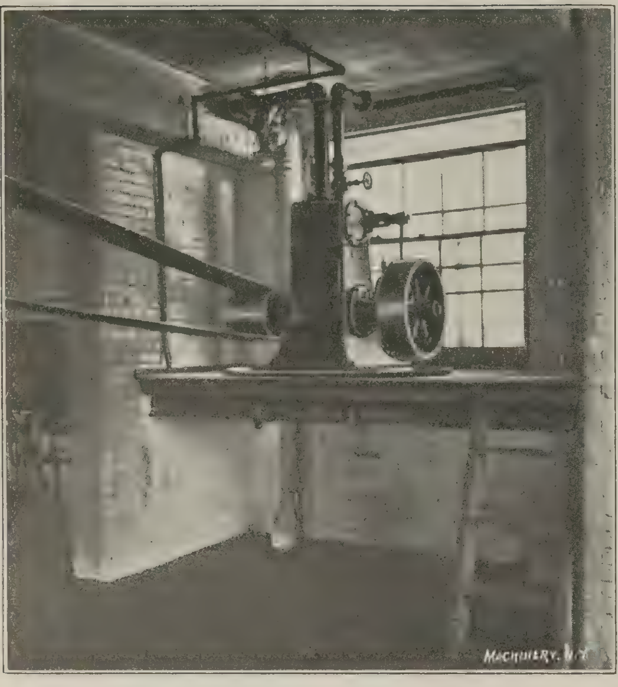


Fig. 7. One of the "Case" Engines used for Power.

walls are carried up through the building, and steel I-beams laid into the piers at the proper height above each floor, the engine being located high enough to give head room under the driving belts. The illustration, Fig. 7, shows one of these engines as mounted in its position in the factory. The exhaust from each engine goes into a return riser, passes through a feed-water heater in the basement and then to the roof, where, in the winter time, it is turned into the heating system. This system of driving has been complimented many times by visiting engineers.

The three lower floors of the main building were designed for a load of 400 pounds to the square foot, without undue deflection, and the two upper floors for 300 pounds to the square foot (see Fig. 2). The use of heavy cast-iron saddles to carry the floor girders, as shown clearly in Fig. 1, *F*, permits posts to be placed end to end, and so constitute a solid post from foundation footings to roof. With the comparatively slight shrinkage of wood in the direction of its length there is but little change throughout the whole post, and hence this can be used for fastening post hangers to carry the lines of shafting with a minimum of annoyance from changes in alignment, and changing loads upon the floors do not affect the shafting.

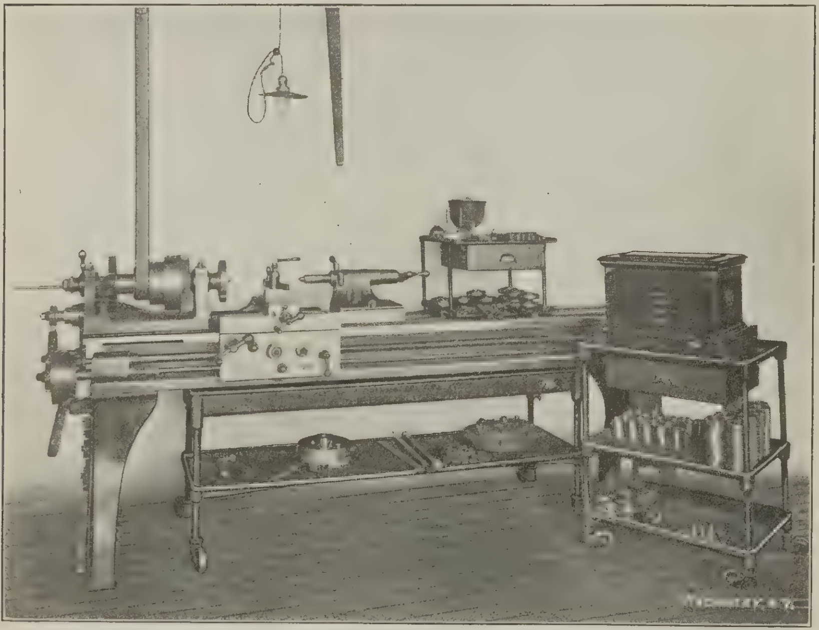


Fig. 8.

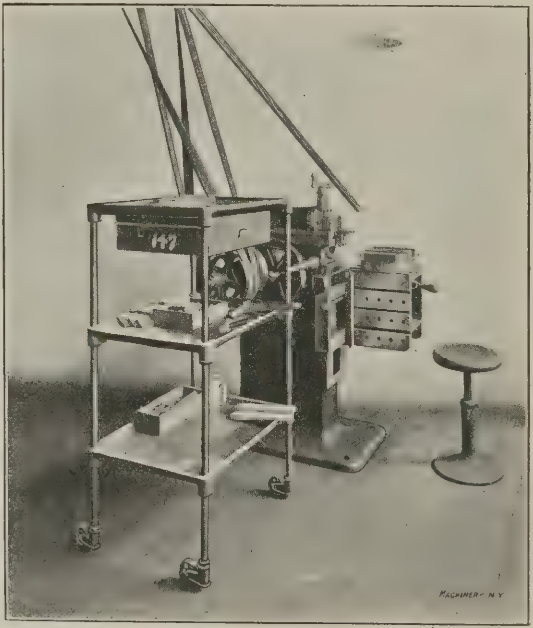


Fig. 9.

All the Machine Tools in the Shop are Equipped with the New Britain Machine Company's "Shop Furniture."

In designing the saddles care was taken to have the supporting flanges come underneath the plates upon which the floor beams rest, so as to leave the relatively large plate in tension, and the supporting brackets, which are smaller in cross section, in compression, thus adapting their design to the characteristics of cast-iron, of which they are constructed. Inasmuch as the posts pass through the floor, provision must be made for supporting the floor around the posts, and spiking pieces consisting of strips of plank are nailed on the sides of the girders at their abutting ends for this purpose. These strips are visible in Fig. 1, *F*, directly over the saddles at the top of the columns.

Up one-and-a-half flights, and separated from the shop by the fire wall, are the offices of the company. Their plan is clearly represented in the second floor plan in Fig. 5. The main rooms occupy the whole front of the building and comprise offices for the bookkeeping department, the sales department, the stenographers and the secretary. These individual rooms secure to each department the proper degree of privacy, yet, by a system of windows between, as indicated in the plan and shown in the two views in Fig. 1, *B* and *C*, a view may be had of the different apartments from any one room, and a proper oversight kept. The offices are finished in dark wood wainscoting and burlap to harmonize.

The superintendent's office, Fig. 1, in the southeast corner of the machine room on this floor, opens into the general suite through the fire wall. It also is supplied with generous window space on shop sides, so that it commands a view of the entire machine room.

In the office system liberal use is made of the card index in keeping records, the large omnibus of information cards being the principle assistance of the sales manager, and shown in the illustration of his office, Fig. 1, *C*, where it is daily wheeled from the vault.

The shipping room is on the first floor under the offices, and is thus divided from the shop by fire wall. Here is kept a stock of finished goods, so that a fire on either side of the wall will not entirely upset business; for on one side are the finished goods, and on the other side, at all times, goods partly completed. The floor being just the same distance from the ground as the average wagon bed, makes the loading of machines or merchandise exceedingly easy.

On the floor over the main offices are the drawing room, the directors' room and a store room for office supplies. The drawing room is so located as to receive a north light. A large dark room is a convenience enjoyed by the blue printer, and shared by him with the photographer.

On all repetition work the company's blue prints are 11 x 14 in size. They are mounted on fiber board about 1-16 inch thick, and given two coats of white shellac varnish. The edges of the prints have a tin binding to prevent fraying, and the insertion of a grommet at the top makes a durable eyelet to hang these up by. Prints so mounted ten years ago are in good condition to-day, although worked from continually as the job has been repeated during that time.

In the office stock room, in which are stored the supplies of printed matter and office sundries, boxes are provided in which all printed matter and supplies are packed, thus keeping them fresh and free from dust. A careful card record is kept of the contents of each box, so that when it is desired to find a given article or printed form, it is only necessary to turn to the card to secure information as to the number of box in which the article wanted will be found.

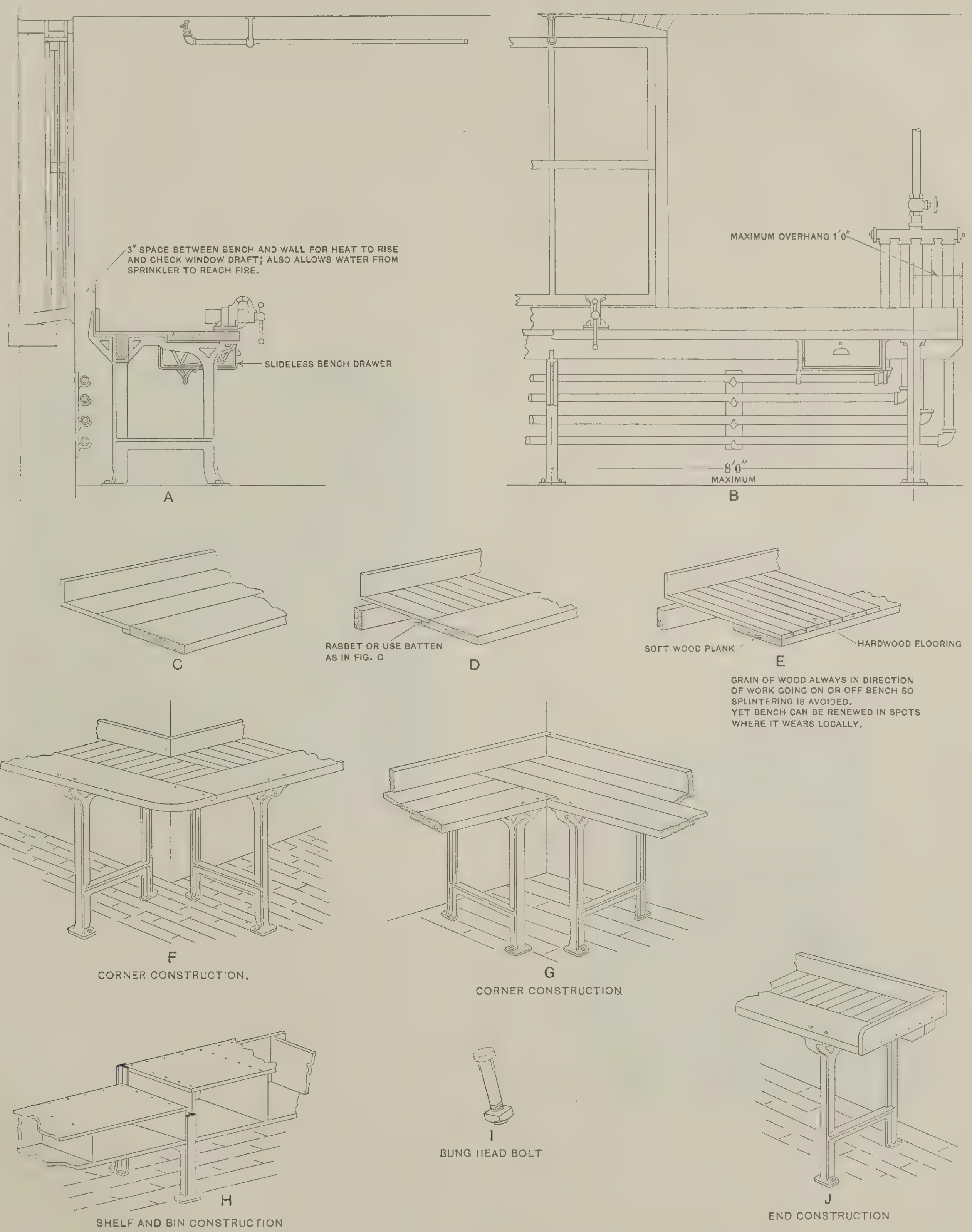

3" SPACE BETWEEN BENCH AND WALL FOR HEAT TO RISE AND CHECK WINDOW DRAFT; ALSO ALLOWS WATER FROM SPRINKLER TO REACH FIRE.
SLIDELESS BENCH DRAWER
A
MAXIMUM OVERHANG 1'0"
8'0"
MAXIMUM
B
C
RABBET OR USE BATTEN AS IN FIG. C
D
SOFT WOOD PLANK
HARDWOOD FLOORING
E
GRAIN OF WOOD ALWAYS IN DIRECTION OF WORK GOING ON OR OFF BENCH SO SPLINTERING IS AVOIDED. YET BENCH CAN BE RENEWED IN SPOTS WHERE IT WEARS LOCALLY.
F
CORNER CONSTRUCTION.
G
CORNER CONSTRUCTION
H
SHELF AND BIN CONSTRUCTION
I
BUNG HEAD BOLT
J
END CONSTRUCTION

Fig. 10. Details of Work Benches with which Plant is Equipped.

The fireproof vault, which extends up from the basement through three stories, is built into and made a part of the west wall and fire wall previously mentioned. Located thus, use can be made of the fireproof storage on either side of the wall as may be desired. This will be seen in plan of third floor, where it was thought best to divide the vault, as shown, so that half is used for the drawing room for safe keeping of tracings, and half accessible from shop for small tool storage.

The grouping of the general offices, superintendent's office, drawing, pattern and model rooms will be noted as convenient with respect to frequent consultation and close watching of new work in its various stages from conception to finished articles.

Heating System.

The factory is heated by exhaust steam on the overhead main system. The object of this, as is well known, is to maintain a uniform direction of flow of the steam and condensation. From the exhaust pipe in the attic a back pressure valve compels travel of steam through the main along the roof. This main is enlarged for one length of pipe, preceding the introduction of an oil eliminator, to provide one square inch area of pipe to each 1½ pounds of steam passed per second. The waste from this eliminator is trapped into the sewer, and beyond this point all returns from the heating system are condensed and used in the boilers, and so far there has been no appearance of any oil having come over. It will be noted that the large main along the roof is just sufficient to take care of the added exposure on that floor, and as a matter of fact it will keep the sprinkler pipes from freezing, even though the side wall coils are shut off. These side wall coils all have a corner in them or are mitered to provide take-up in case of unequal expansion. They are proportioned on a basis of 1 square foot of heating surface to each 4 square feet of glass in the room; another square foot of heating surface for each 20 square feet of wall, and another square foot of heating surface for each 600 cubic feet of contents. One and one-half-inch pipes are used throughout the coils.

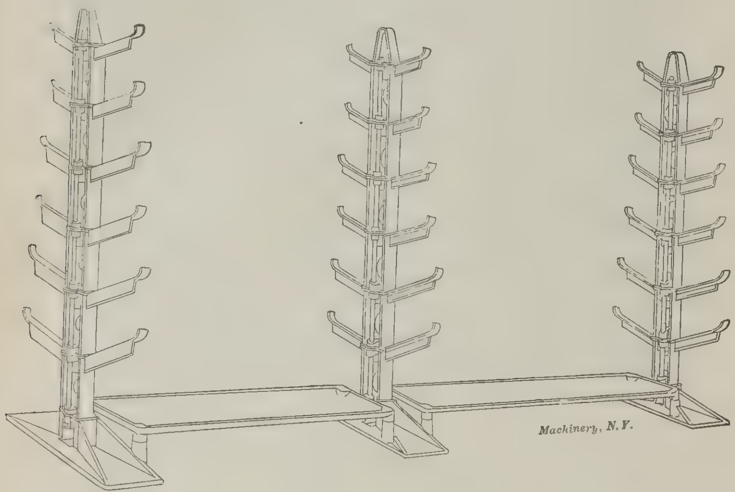


Fig. 11 Stock Rack.

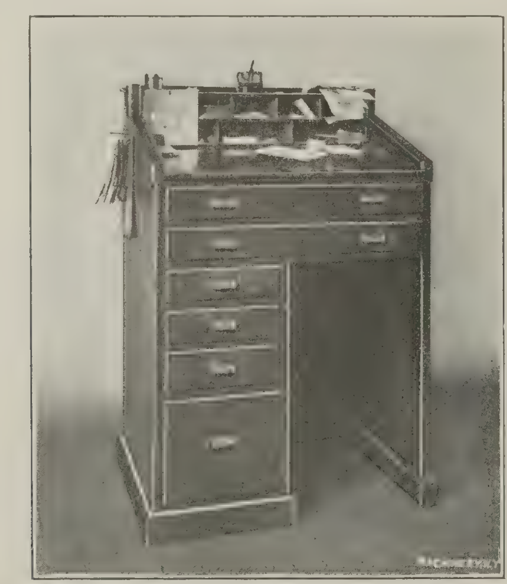


Fig. 12. Foreman's Desk, built high, so he can Overlook his Room when Sitting at his Desk.

In the basement, owing to the difficulty in getting returns back, the coils were placed overhead. The outside stairway is heated by a single pipe from top to bottom, and the closets by a hairpin loop, running from top to bottom. The lowest returns are helped into the tank of pump and receiver by a suction tee.

The office is heated by direct-indirect radiators. A screened duct through the brick wall delivers fresh air under the base of radiator, and this may be mixed with the room air or shut off entirely, as desired. A greater amount of heating surface, of course, is provided here than would be in the shop.

Fire Protection.

The city is supplied with water by the gravity system, and there is 75 pounds pressure available at the company's works for fire protection. In addition to this the underwriters requested a 10,000-gallon tank to be placed on the roof, with the bottom 10 feet above the highest sprinkler. To keep the tank from freezing, it is located directly over a steam-heated room in the building, which has an opening through the ceiling, allowing the heat to rise against the bottom of the tank. It was a question whether this system of heating would be sufficient in all weather, but in the severe winter just passed the result justified the arrangement.

There are tinned fire doors on all openings, these doors being supplied with automatic closers and fusible links, melting at 160 degrees Fahrenheit. The sprinkler heads are set at the same temperature. The hydrant and hose are made to interchange with the city fire department's standard threads. A dozen fire pails are provided for each 5,000 feet of floor space, and chemical extinguishers still further augment the protection. Suitable receptacles for the waste are placed on each floor, and benches kept 3 inches away from the wall, as will be noted in the details of bench construction, Fig. 10.

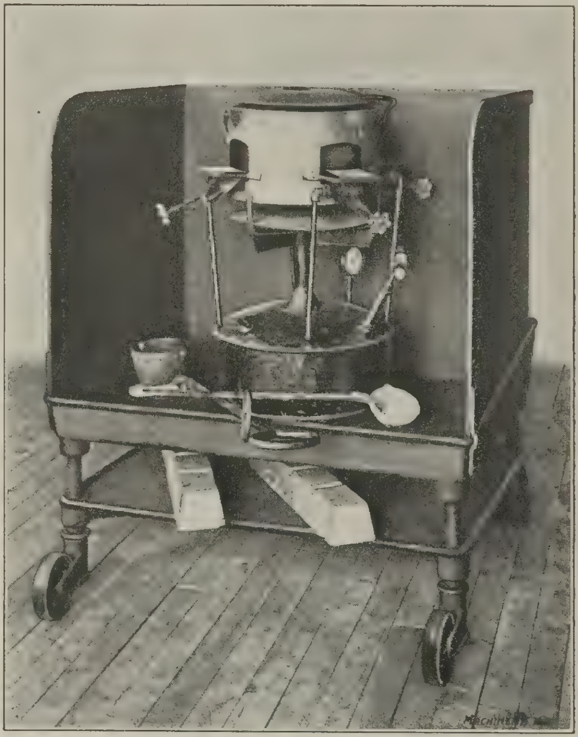


Fig. 13. Portable Babbitt Melter, with Protecting Stand.

Lighting.

The shop is lighted by incandescent lights, the current for which is supplied by a dynamo in engine testing department. This dynamo may be run with basement engines or any engine which may then be on the testing plate, for its final run and regulation adjustment. When the shop is not running, current may be taken from the city service for convenience of the office or night watchman.

Products.

The New Britain Machine Company is engaged in the manufacture of patented specialties, which include a chain saw mortiser—a woodworking tool; the Case steam engine, already mentioned, a small high-speed machine built in sizes from 2 to 25 horse power, and it was here that "Shop Furniture" originated. In fact, the term shop furniture was coined to describe the class of goods made here, which includes racks to hold stock in bars, various styles of lathe pans, tool racks and bench legs, every effort having been made to standardize many of the needful things in a machine shop, which have been made hitherto by each shop for itself.

One article of "furniture" recently placed on the market is a stock rack, shown in Fig. 11, for holding merchant bars of stock, or other material. The three uprights, spaced six feet apart, with six graduated double hooks in each upright, are of proper proportions to equally support bars of merchant steel 18 feet long and will hold upward of 7 tons without danger of overloading. The unit idea is carried out so the rack can be expanded or contracted to meet changing requirements. The hooks and tension bolts are of steel and distance pieces of cast iron. This selection of materials in combination gives the greatest strength with least weight. The pans at the bottom are useful for holding short pieces and odds and ends.

When the shop was completed it was equipped throughout with work benches designed by the company and which proved so satisfactory and seemed to embody so many good features that the legs and other metallic parts have since been put on the market, as another addition to their shop furniture line. The details of the benches are so clearly outlined in the large engraving that description is unnecessary. We believe, however, the sketches showing the bench construction will offer to many of our readers several ideas that will be appreciated.

Commencing four years ago, the practice of the company has been to discard about twenty machine tools each year, replacing them with more modern types, with the result that there is hardly an old-fashioned tool in the shop, and the equipment represents the most advanced ideas of modern builders.

Every lathe in the shop is provided with a portable lathe pan of the company's make, and lathe rack to slide on ways and carry the small tools, waste, oil can and light work. These lathe racks are easily removed from the ways, if desired to work up to full length of bed. The proximity of a portable tool rack and workman's chest or kit is believed to still further enhance his productivity.

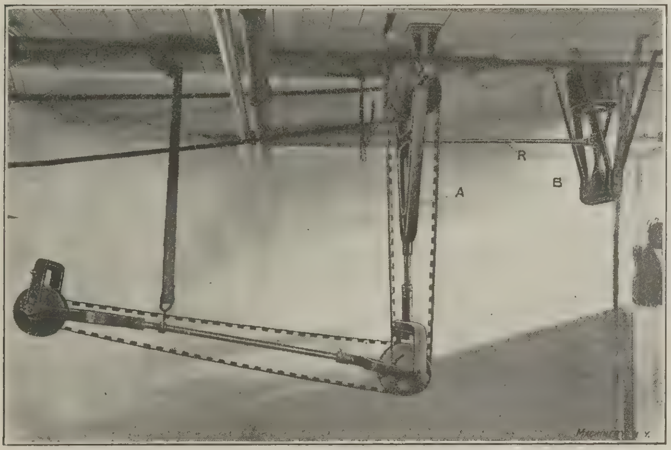


Fig. 14. Counterbalance Device for Swing-frame Grinder.

A Portable Babbitt Melter.

In connection with the assembling work on the chain mortisers, there is considerable babbitting to be done in place. This is true of most woodworking machinery, and is a practice which persists, owing to the facility with which the ordinary mill man can make repairs of babbitted bearings. To handle this work expeditiously, a portable babbitt heater is used, which can be moved down the line of machines being assembled, as shown in Fig. 13. This consists of a gasoline four-burner melting pot placed in a New Britain Machine Company's pan rack hooded about on three sides and cut down low to bring the melting pot down to a convenient height for ladling. The capacity of the pan is more than the tank of heater.

The lower shelf makes a convenient place for babbitt, while ball bearing swivel casters of generous size insure prompt facing about and easy travel. By having the melter within a foot or two of where the babbitt is actually poured, there is no necessity or excuse for overheating same. This is the only fire in the main building. It is used, of course, only when babbitting is to be done, with a workman constantly beside it. When the job is finished the fire is put out. Should there be any leakage or ignition of gasoline, through accident, the instructions are to push the outfit out into the yard.

Swing-frame Grinder.

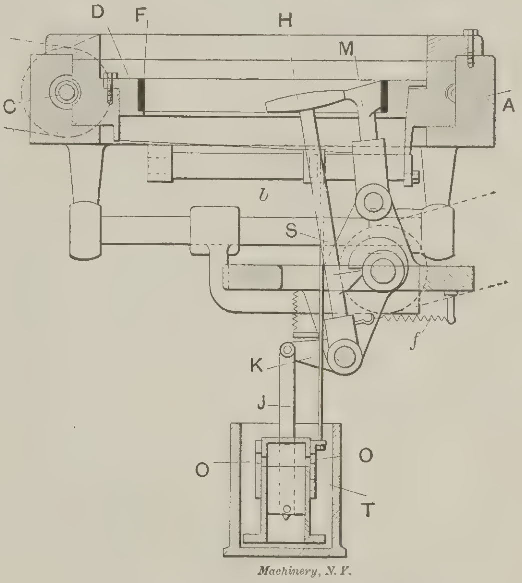
The limitations which surround the use of a swing frame grinder are splendidly eliminated by the mechanism shown in Fig. 14. Ordinarily with low head room, the labor necessary to move the wheel over a long surface is very great, since with even a small angle of motion the labor at both extremes amounts largely to a lift. To overcome this the counterpoise weights shown were devised. These weights lend themselves to the work of balancing the wheel mechanism immediately it is moved off center, and thus a long swing—aggregating some five feet—may be accomplished with ease. This casting cleaning method seems better suited than air chippers on the large flat surfaces of the class of castings handled here. In the illustration, *A* is the swing frame, connected with the counterpoise lever *B* by the rod *R*.

* * *

AUTOMATIC PISTON RING HAMMER.

The accompanying illustration is of an ingenious tool for expanding piston rings by pening on the inside of the ring. Piston rings are frequently expanded by hammering with a hand hammer, but it is difficult to so locate and graduate the blows as to expand the ring uniformly and cause it to bear against the walls of the cylinder with uniform pressure around the whole circumference.

This is automatically accomplished, however, by the hammering machine, which delivers its blows in such a manner that the greatest stress in the piston ring is set up at a point diametrically opposite the joint. The hardest blow of the hammer is delivered at this point and the blows then decrease symmetrically in each direction until the joint is reached, where they are at a minimum, with the result that a uniform spring is set up in the ring. This insures that the ring will wear evenly and prevents the cylinder from wearing ovally, a difficulty met with when piston rings are used whose spring is not uniform.



Machinery, N.Y.

Automatic Hammer for Pening Piston Rings.

The machine consists of a table *A*, with a revolving ring *D*, on the top, rotated by a screw *C*, and inside which the piston ring *F* is placed, and secured by three clamping screws. Several sizes of revolving ring are used to suit pistons of different diameters. Inside the ring is a small wedge-shaped swage *M*, kept out of contact by a spring. This swage is struck on the head by a hammer *H*, actuated as shown by a cam *S*, and spiral spring *f*. The hammer spindle is fitted with a bell crank *K*, governed by an oil dash pot, *J*, with a by-pass, as shown. The discharge of oil is regulated by a ring *T* round the cylinder, opening more or less perforations *O O*, through which the oil can escape. This ring is moved gradually up and down by the incline *b*, on the under side of the revolving ring, and so the force of the blow on the head of the swage is regulated. The machine is made by Act. Ges. Davy Robertson's Maschinenfabrik Filiale, Hamburg.

* * *

The Henry R. Worthington Hydraulic Works now nearing completion at Harrison, N. J. (suburb of Newark), contains 18 acres of floor space and will accommodate 5,000 employes.

EARLY STEAM ENGINES.—3.

CENTRE SQUARE PUMPING ENGINES AT PHILADELPHIA

In the article by Mr. Bell, in the June number, upon the beginnings of the steam engine in England, and in the extract from the writings of James Watt, under the heading of "Early Steam Engines," in the July number, the work of James Watt—the father of the steam engine—was treated somewhat in detail. It now seems appropriate to shift to America and see what was being done to introduce the steam engine into this country.

Some time ago reference was made in MACHINERY to the ancient pumping engine at Belleville, N. J., which was built by Hornblower in England and brought over here to drain the Belleville copper mines of Col. John Schuyler. This was in 1753 and it apparently caused no awakening to the possibilities of steam, as did what was perhaps the most important early steam engine installation in this country—namely, that of the Centre Square Water Works, at Philadelphia, in 1801. Drawings showing the probable design of the engines and boilers of these water works were made by Frederick Graff, one of the early engineers of the Philadelphia Water Works

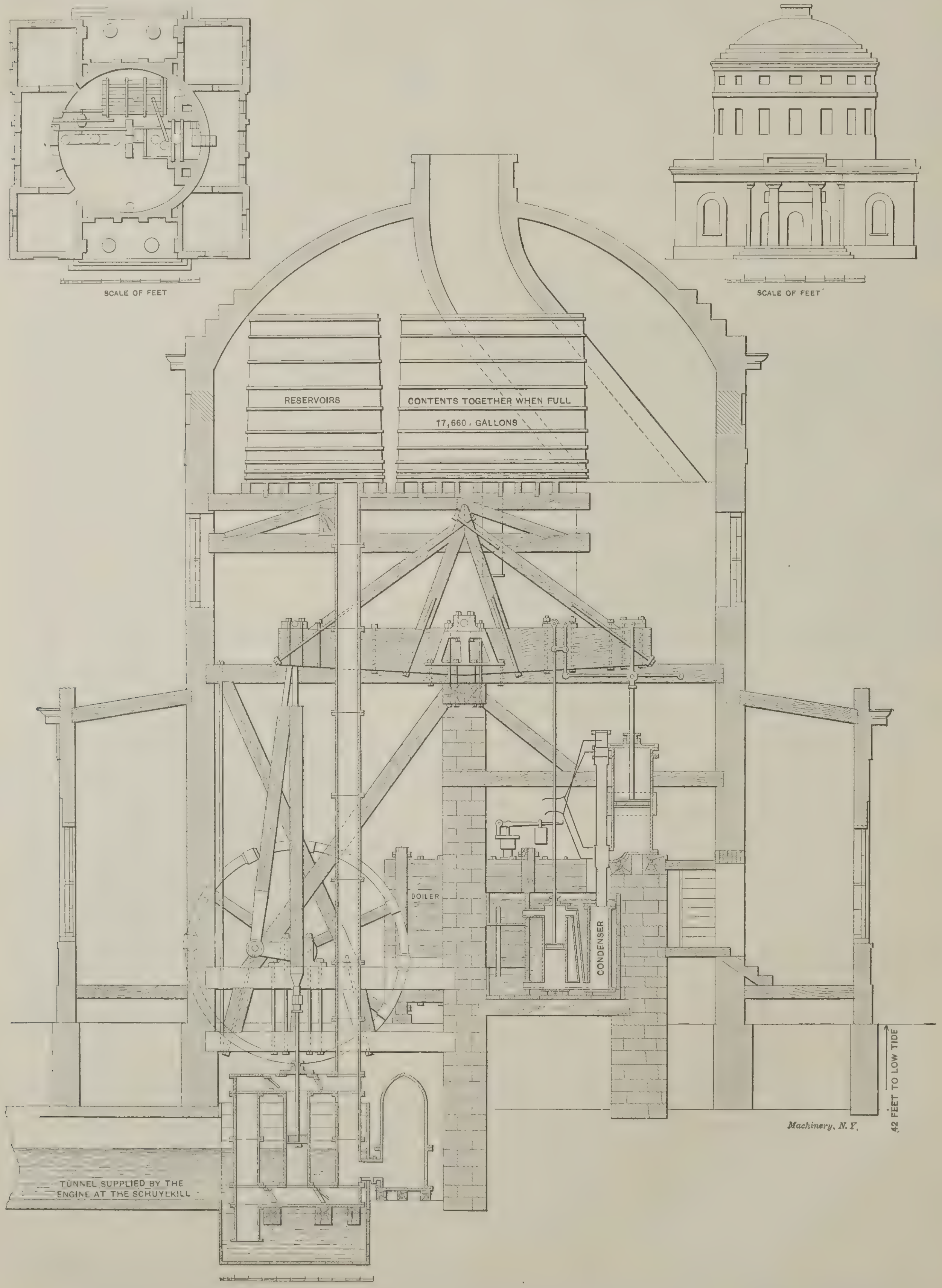


Fig. 1. Centre Square Water Works, Philadelphia; Section of Building showing the old Pumping Engine originally Installed there.

system, from data in his possession, and are now at the Franklin Institute, Philadelphia. They were reproduced in *The Engineering News*, May 14, 1903, from which publication our engravings have been made. The particulars with regard to these works, which follow, are taken from the annual report of the Chief Engineer of the Water Department of Philadelphia for 1875. This is now a valuable and rare pamphlet, containing as it does much historical matter.

At the end of the eighteenth century Philadelphia was confronted with a fever epidemic resulting from the drainage from cesspools reaching the strata of the earth where the water lay that supplied the numerous wells from which the city secured its water. The covering of the ground in the heart of Philadelphia with buildings and pavement had prevented rain from soaking in to replenish the wells and the digging of the cesspools through the clay substrata to the porous ground beneath had allowed the drainage to mingle with the water, with the result of the fever epidemic mentioned. Benjamin Franklin first aroused public sentiment to the importance of a pure supply of water by presenting a plan for bringing water into town by means of pipes. Among other schemes was a proposition for a reservoir in Centre Square having an elevation of 40 feet to "throw the water up into fountains, and the water of the Schuylkill to be conducted to and raised into said reservoir by steam, at an estimated cost of $75,000." This latter plan was adopted in 1799 by the City Councils, and the Centre Square Water Works were located where the city buildings now stand.

To raise money was difficult, and the committee jointly and individually had their notes discounted to carry on the work, the subscribers to the water loan receiving a three years' supply free from January, 1801.

Steam, the motive power, was then a novelty, there being but three steam engines of any considerable size in the United States: the imported Hornblower engine mentioned above, at Belleville, N. J.; another at a sawmill, in New York; and the third in Philadelphia, used for grinding plaster, by Oliver Evans; it was therefore difficult to find skillful and experienced persons to construct the engines. A contract was made with Nicholas J. Roosevelt, of Soho Works, on the river Passaic, in New Jersey, for the construction and erection of two steam engines of capacity to raise three million gallons per day 50 feet high, to maintain and keep them in repair five years, for the sum of $30,000. These were the largest and first pumping engines in the United States, and with the tools and experience of the time it was a great undertaking.

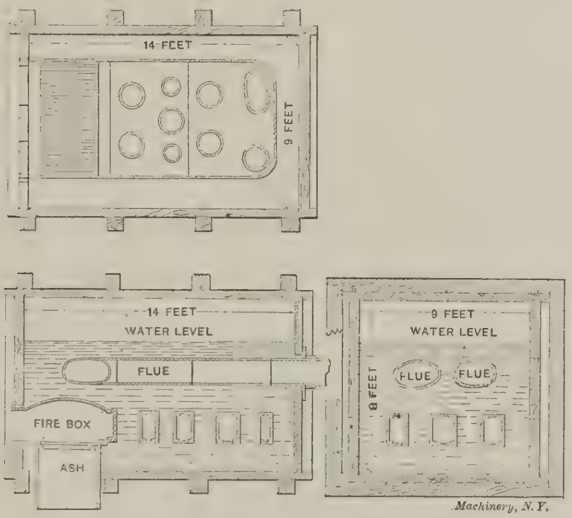


Fig. 2. Wooden Steam Boiler used at the Centre Square Water Works from 1801 to 1815.

The City having determined to obtain its supply of water, the following is a general description of the arrangements and connections:

A basin was formed on the Schuylkill River, at the foot and on the north side of Chestnut Street, extending from low water-mark 200 feet eastwardly, and 84 feet wide, provided with a set of tide-lock gates. The bed of this basin was three feet below low water-mark; thence the water passed through a sluice to a second basin or canal 40 feet wide and 160 feet long. The sides of both basins were inclined, paved, and coped with marble; at the head of the canal was a sluice-gate set in marble, which admitted the water into a subterranean tunnel of oval form, six feet in its greatest diameter, and 300 feet long, cut through solid rock nearly the whole distance, its bed level with low water, and emptying into a shaft or well 10 feet diameter, and 39 feet deep, 22 feet of which was cut out of solid rock, and in which was placed the pump, the bottom chamber being on a level with low water. This was called the Lower Engine House, and was located at the northwest corner of Chestnut and Schuylkill Front (Twenty-second) Streets, where the water was raised into a brick tunnel six feet in diameter, and 3,144 feet in length, leading the water under ground down Chestnut to Broad; thence to the Centre Square Engine House, where it was again pumped to a height of 36 feet from the surface, or 50 feet from bed of brick tunnel, into two tanks of 17,094 ale, or 20,868 wine gallons capacity; from thence it descended into an iron chest 4 by 8 feet, outside the building, to which the wooden mains were connected that supplied the city. Two 6-inch down Market, one 4½-inch down Arch, and one 4½-inch down Chestnut to Front Street; from these the water was distributed through 4-inch and 3-inch logs.

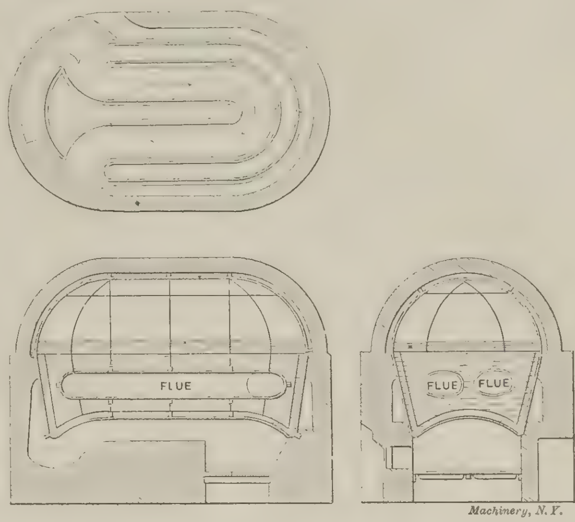


Fig. 3. Cast Iron Boiler used at Schuylkill Engine House, Philadelphia.

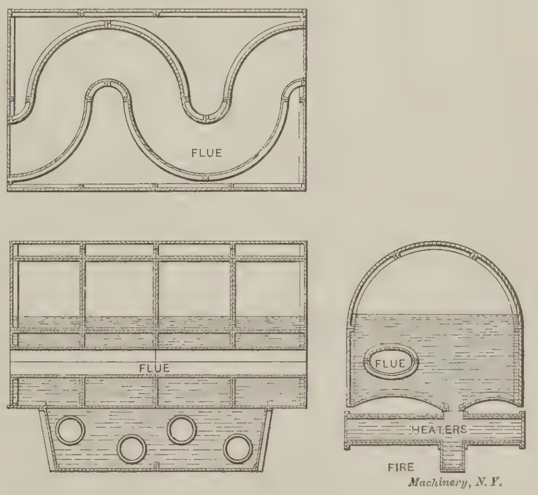


Fig. 4. Cast Iron Boiler, Centre Square Works, 1804.

The Schuylkill engine house was 66 by 54 feet, built in the most substantial manner to contain two engines and pumps, though only one was ever put in.

The Centre Square engine house was an exceedingly handsome building of marble, the lower story containing the offices, committee and engineers' rooms, built in the form of a square of 60 feet, 25 feet high, with two porticos, and surrounded a circular building 40 feet diameter and 60 feet high, covered by a dome, through the center of which the stack was carried.

The engines in both buildings were very defective in every respect, the lever beams, flywheels, shafts and arms, cold water pumps and cisterns, *being all made of wood.* The main steam cylinder of the Centre Square engine was cast in two pieces, united by copper, the joints being secured externally by a cast-iron band 18 inches wide; and although it was but 6 feet 6 inches long, and 36 inches in diameter, nearly four months were occupied in boring it out fit for use. This is an incredible statement, but it seems well confirmed.

The boilers to both engines were wooden boxes 9 feet high, 9 feet wide, and 15 feet long, made of five-inch white pine plank, securely bolted through and braced on the outside. The fire-box inside the boiler was of wrought-iron, with vertical flues of cast-iron; subsequently, a cast-iron boiler was substituted.

At that time wrought-iron could not be obtained in sheets larger than 15 inches by three feet when it was squared; which had to be done by the purchaser. All the castings were patched by gun boring, cement, and hard-solder.

The pumps were double-acting force, and had to be lined with sheet copper before they could be made air-tight. At first they were made without air-chambers, which were added to the Centre Square pump in 1810, but were useless until lined with sheet lead.

The first cast-iron boiler built was used at the Schuylkill Works, and was so successful that a similar one was placed at Centre Square.

In 1807 the forging and finishing of a 4-inch piston rod 10 feet long was thus noticed in the annual report of the Watering Committee—"The workmanship of this piece of iron could not, in the opinion of our Committee, have been better done in any country." This rod was generally looked upon as a remarkable piece of work.

In 1809, a cast-iron flywheel shaft replaced a wooden one.

Fears were entertained that the price of wood, $4.50 per cord, and of bituminous coal, 33 cents per bushel, would be enhanced by the amount used by these engines, and that there would be difficulty experienced in procuring a sufficient supply.

These considerations, with the trouble of keeping the engines in repair, and the constant difficulties with the boilers, as well as the small storage in the tanks at Centre Square Engine House, rendered the supply intermittent and uncertain, which led Councils to have another examination made, which finally led to the establishment of the Fairmount Works.

Up to 1815, the city had received no direct pecuniary benefit from the water works, in fact not enough was realized from water rents in any one year to pay for the fuel and the working of the engines.

The cost of the Schuylkill and Centre Square Works, with yearly expenses added, from March, 1799, to September 1, 1815, when steam was started at Fairmount, was $657,398.91, the whole gross receipts amounting to but $105,351.18, leaving a deficiency of $552,047.73, without interest.

Yet it cannot be said this sum has been lost to the City, as many indirect advantages have arisen from it. Character and impetus was given to the City, much was done to improve its sanitary condition, an important feature which added to its many attractions as a place of residence. Nor was the early experience thus acquired by her mechanics a small matter, for perhaps to their pumping engines and the practical knowledge derived from them, may be attributed much of the preeminence which Philadelphia early enjoyed.

The original works at Fairmount, driven by steam power, were commenced August 1, 1812, to supplant those at Broad and Chestnut, and were put in operation September 7, 1815.

In a house at the foot of Fairmount Hill, was erected a Bolton and Watt engine of 44-inch cylinder, and 6 feet stroke, working a double-acting pump of 20-inch diameter and 6-feet stroke, raising the water through a 16-inch main, 239 feet long, into a reservoir 102 feet above low water in the Schuylkill. The boiler had a cast-iron case with vertical flues or heaters of wrought-iron, carrying 2½ to 4 pounds pressure of steam.

Although at this time considerable improvement had been made in building machinery, yet not a single furnace could be found large enough to cast the steam cylinder entire, the nozzle pipes being cast separately and bolted on, though their weight was but 1¾ tons.

Before starting the works a contract was made with Oliver Evans for one of his high pressure engines, then coming into notice. It was accordingly put up, dimensions as follows: steam cylinder 20 inches diameter and 5 feet stroke, with a pump 21 inches diameter and 4 feet stroke. This engine was supplied by 4 cylinder boilers 30 inches diameter and 24 feet long, upon which a pressure of 220 pounds was sometimes carried. The engine upon trial, raised 3,072,656 ale gallons in 24 hours, running 24¾ revolutions per minute, and carrying 194 pounds of steam with a consumption of 13 cords of wood. It was put to work December 15, 1817; the cost at that time to raise 2,300,000 ale gallons per 24 hours being $84.50.

The population rapidly increasing, the difficulty and expense of keeping up a sufficient supply with the machinery then in use kept Councils constantly on the alert for a cheaper and more copious supply of water. The expense will be seen by the estimate of the working of the Oliver Evans engines, as made by the superintendent of the works for one year, for an average of 2,300,000 ale gallons per day:

Six men at $9.75 per day	$3,558.75
Tallow, and chandlery, etc.	1,250.00
3,650 cords wood, cording, hauling, etc.	24,550.00
Wear and tear of machinery	1,500.00
	$30,858.75

or $36.60 per million gallons pumped into the reservoir.

* * *

USE OF THE STROBOSCOPE.

It is a peculiarity of vision that impressions on the retina do not fade instantly but persist for a fraction of a second after a change has taken place in the aspect of the object viewed. This persistence of vision is what enables a fairly good view of a fair ground or baseball field alongside of a railroad track, to be seen from the window of a rapidly-moving train, when, if the train were standing still, all that could be seen would be a high fence with narrow cracks between the vertical boards. When the car carries one by the fence rapidly the eye receives a series of views of the field through the cracks, which blend together and give the panorama effect. This peculiarity is taken advantage of in investigating the action of certain vibrating or revolving mechanisms like engine flywheel governors, etc. If a rapidly-running flywheel governor is seen for a fraction of a second at one spot at every rotation, it appears to the eye to stand in space and under that condition the in-and-out movements caused by changing load, may be readily seen. One method of obtaining this effect is to mount a radially-slotted disk on the flywheel shaft so that the slot covers the portion of the governor to be watched. In front of this disk is another slotted disk which stands stationary. Now if a strong light illuminates the object a flash of reflected light will reach the eye at every revolution. The same stroboscopic effect was obtained in another way in the elaborate investigations of the Pelton water wheel which were carried on some months ago. To perfect the shape of these buckets so that they should have the maximum of efficiency and durability it seemed necessary to observe the action of the jet as it impinged on the buckets, but to get a perfect visual impression the buckets should stand still, which, of course, was impossible in running tests. An arc lamp was arranged with a shutter, which was worked in synchronism with the revolving water wheel. At every revolution a flash of light was directed upon the jet and buckets, giving them the impression of standing still while the water entered the buckets and flowed out at the sides. With the same apparatus instantaneous photographs of the jet and buckets were taken.

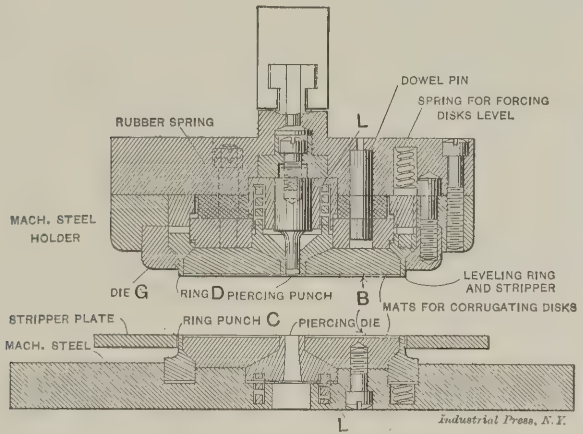
* * *

A comparatively new time- and labor-saving product is a self-fluxing solder. A bar of the solder consists of a tube, filled with the flux, which is pinched together at short intervals so that the flux is divided into small portions contained in cells or pockets. As the bar is used the contents of the cells are successively released upon the work, thus relieving the user from the necessity of carrying about a pot of acid and applying it to the work with a brush.

NOTES ON DIE MAKING.

FRANK E. SHAILOR.

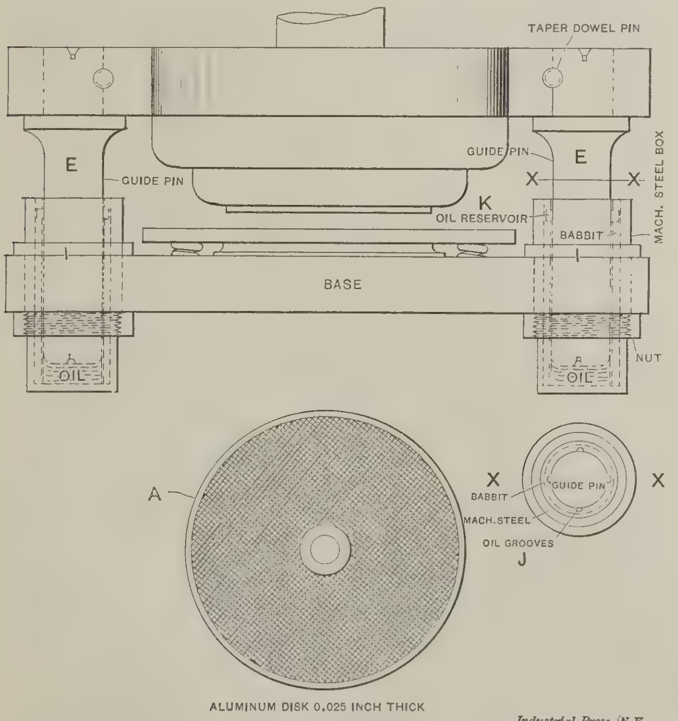
Through the courtesy of Mr. Herbert M. Smith, Works Engineer of the Stanley Instrument Co., the die, Fig. 1, is shown. This die was designed by the above-named gentleman and contains several novel features that will be found valuable to many engaged in die making. As the sub-press die, frames, and power sub-presses are of standard dimensions, it too frequently occurs that a die is required of size that necessitates specially made frames, and invariably a specially made press. The sketch, Fig. 1, shows a practical way to construct a die that not only is a compact self-contained die, but can be fitted to any style of press (of sufficient strength) having any length of stroke.



Industrial Press, N.Y.

Fig. 1. Vertical Section through Die.

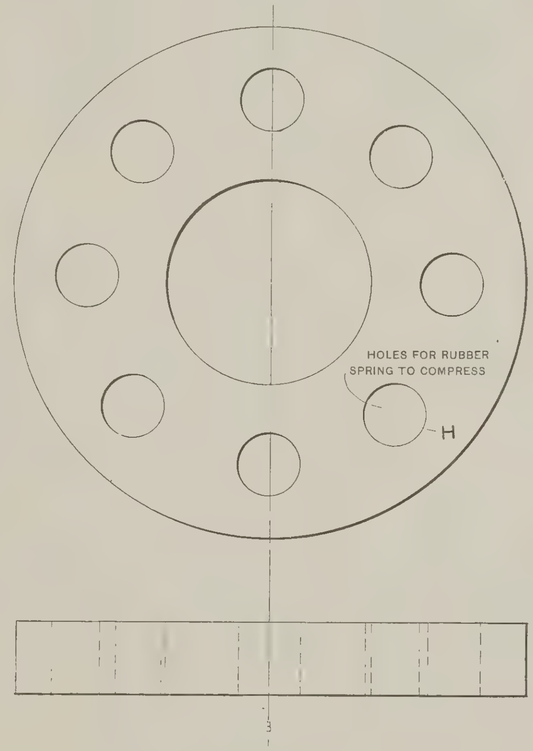
This particular die was designed to produce the disk shown at *A*, Fig. 2, and previous to its introduction the disks were blanked out with a plain open die and then leveled by hand. The disks are of aluminum, 99 per cent. pure, therefore, very soft, and as it is very essential that they should run as true as possible, great difficulty was experienced in leveling them. The corrugating mats *B B* were designed to level the disk and also to set, or stiffen the metal, and they proved a success, for when the disks leave the die they are as nearly level and true as is possible to make, and so stiff that they can be handled quite roughly without injury. The disk was not corrugated its entire surface owing to the fact that the mat would be obliged to act as the blanking punch, and if the corrugations extended clear to the edge of mat, same could not be sharpened when dull. Therefore the rings *C D* were introduced. The ring *C* acts as the blanking punch, and ring *D* acts as a leveling ring. The die is guided by means of two guide or pilot pins, *E E*, Fig. 2, and as the gate of press descends the rings *C D* are the first to act on stock to be punched, gripping it from above and below and holding the stock securely. Then as the press continues downward the rings settle back, still holding the stock, and the mats *B B* grip the blank.



Industrial Press, N.Y.

Fig. 2. Side Elevation of Die and Plan of Guide; also Sample of Work.

The rubber spring (which is one of the features) exerts an increasing pressure on the metal, pressing it into the corrugations on the mats. The press is so adjusted that the ring *C*, which is the blanking punch, comes exactly flush with the die *G*, but does not enter. On the upward stroke of press the springs and rubber plate force the moving parts back to their original position, and force the disk out of the die, and the surplus stock off the ring *C*. The rubber plate can be advantageously used in a small place where a very strong spring is required. The tension or spring effect is obtained by cutting holes *H* in the plate, Fig. 3. The more holes there are in plate the weaker the tension, as the holes permit the surrounding rubber to squeeze into them. On the other hand if no holes were cut in rubber plate and same fitted the recess bored for rubber plate, there would be no more spring effect than if a metal plate was used. Rubber does not compress but merely changes shape.



Industrial Press, N.Y.

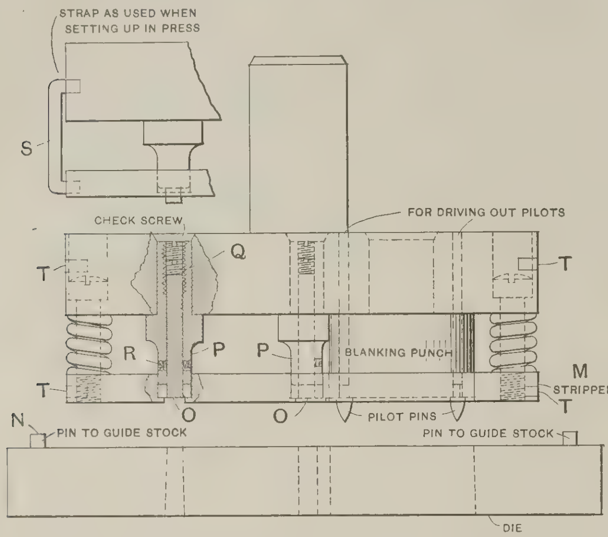
Fig. 3. Spring Rubber Plate.

Another novel feature is that the guide pins are automatically lubricated at each stroke of the press. The pins run in the babbitt boxes *I I*, Fig. 2, which have four grooves, *J*, cut the entire length of the babbitt, and an oil chamber or reservoir *K* recessed near the top. A quantity of oil is placed in the bottom of the box and as the pins descend they force the oil up through the grooves *J* into the reservoir, and as the pins ascend they form a partial vacuum at the bottom of the box, which sucks the oil back to the bottom.

Space will not allow describing the methods employed when making each part of the die, but suffice it to say that with the exception of the mats, screws and holder, the parts were hardened and *accurately* ground, making a smoothly running die. It might be well to mention the method employed in making the square springs *L*.

Frank E. Shailor was born in New Haven, Conn., December 14, 1875. His education was acquired in the high school and the technical part by home study. His shop experience began with the Winchester Repeating Arms Co., New Haven, Conn., where he learned his trade. He has worked for the New Haven Bicycle Co., Stanley Instrument Co., Greist Mfg. Co., Hoggson & Pettis Co., and others with whom he has held the positions of foreman, etc. With one concern he was in charge of the manufacture of cyclometers for two years. His specialties are fine tool work, punches and dies, and accurate jig-making.

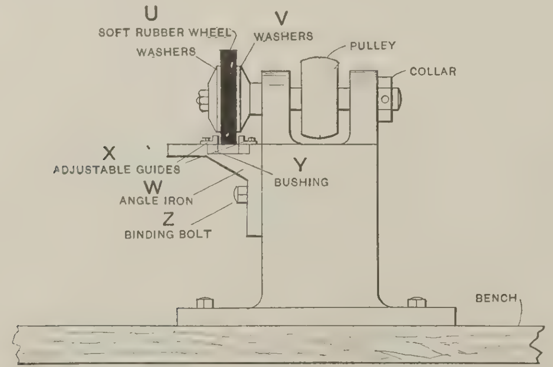
The reader knows only too well what a mean job it is to wind a heavy coil spring and have same a given diameter inside and outside, when finished. A large spring is generally made by heating wire red hot, and winding as many coils as possible before cooling, then reheating and winding more coils. The springs *L L* were made by gripping a piece of round tool steel in the lathe chuck and turning to the given outside diameter. The lathe was then geared to cut a coarse pitch thread and with a square thread tool, the thread was cut sufficiently deep. The inside of the spring-to-be was then bored out to proper diameter, leaving a spring the coils of which are evenly spaced, thereby causing each coil to perform equally its share of the work. With a wound spring the coils are very seldom equally spaced, and when under pressure there is a greater strain on the coils furthest apart, causing the spring to either "set" or break at that point.



Industrial Press, N.Y.

Fig. 4. Die With Stripper Attached to Punch to Flatten Stock.

After all parts of the die were completed the die was assembled, leaving out the springs. The upper and lower part were then brought together until the punches entered dies, care being exercised that upper and lower part of the die were perfectly parallel with each other. The boxes *I I* were then babbitted, first treating the guide pins with a light coating of flake graphite and oil to prevent babbitt sticking to the pins. The writer considers that a large die of above description is far superior to the ordinary sub-press die, inasmuch as it is more compact, and also does away entirely with the cumbersome cast iron frame.



Industrial Press N.Y.

Fig. 5. Machine for Separating Blanks from Stock Strips

Fig. 4 shows a die that is designed to take the place of the plain, open double die. The ordinary double die is made with the stripper fastened to the die and stripper planed out to allow stock to slide through. The reader knows the unsatisfactory results obtained when using a die of this style. The greatest fault is that no two blanks are exactly alike, owing to the fact that the stock is wrinkled and does not lie level on the die. As the punches descend they pierce the stock without leveling same, and as the blanks are afterward leveled it is found that the pierced holes being unevenly spaced will not allow the blanks to interchange. By making the die, as shown in Fig. 4, with the stripper plate *M* fastened to punch-holder and a stiff coil spring at each corner, and so adjusted that the punches do not come quite flush with the face of the stripper, the above-mentioned trouble is nearly eliminated. On the downward stroke of press the stripper *M* presses the stock firmly against the die, holding it level while the punches perform their work. The stock is guided by means of a small pin *N* at each end of die. The stripper should not fit the punches; for if the operator should make a miscut, or should a piece of scrap punching get under the stripper, it would cause same to tilt and bring disaster to the small punches.

Another valuable feature in this die is the manner in which the piercing punches *O O* are constructed. Ordinarily piercing punches are made solid, and if one breaks it necessitates making a whole new punch or grinding the other punches down to same length, greatly shortening the life of the die. The punches shown at *O O* are designed to overcome this trouble. A holder *P* is made and left soft, into which the punch *O* (or rod) is inserted, being backed up by the screw *Q* and prevented from pulling out by means of the screws *R*. Then should one of the punches "flake" off, that same punch can be ground and then forced out by means of the screw *Q* until it is the same height as the others. This style of piercing punch greatly increases the life of a die. This die can be made either with or without the guide pins *E E*, in Fig. 1. If made without the guide pins it is necessary to use the straps *S* to allow aligning punches with die when "setting up" in press. The stripper is forced back and the straps inserted in the holes *T T*. After the die is "set up" and securely fastened the straps are removed.

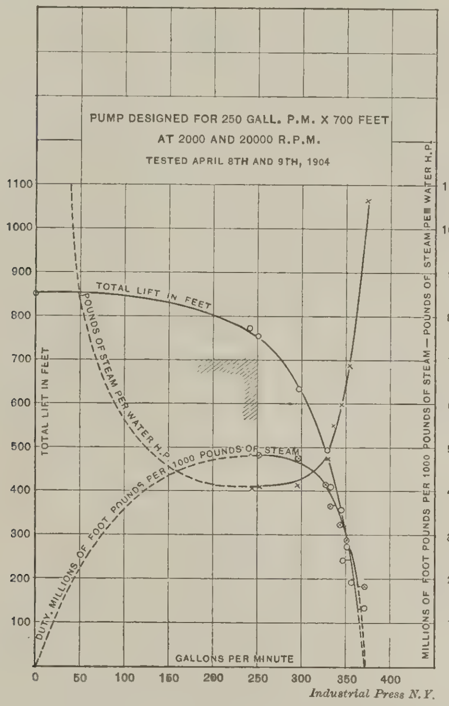
All presses in which double dies are used should be provided with a separator, which is a piece of sheet metal fastened underneath the press to separate the scrap punchings from the blanks. The writer has frequently noticed that in factories where no separator is used the cost of sorting the blanks from the scrap is in excess of the cost of blanking. The reader knows that a sub-press die leaves the blanks in the strip of stock. If the stock is over .02 inch thick considerable trouble is experienced in removing the blanks. Fig. 5 shows a means, designed by the writer, whereby the blanks are forced from the strip without marring them. *U* represents a soft rubber wheel, which is supported on the sides nearly to the edge by the washers *V*. The angle iron *W* is provided with adjustable guides *X* and is recessed at *Y* to receive bushings having different sized holes. A bushing is inserted in the angle iron having a hole somewhat larger than the blanks to be forced out. The guides *X* are then adjusted to allow the strip to slide freely. The angle iron is then raised by loosening the bolt *Z* until sufficient pressure is brought on the rubber wheel. The wheel being power driven, all that is necessary is to place the end of a strip under the rubber wheel and it will roll the strip along, at same time forcing out the blanks.

* * *

TEST OF TURBINE PUMPS.

The development of the steam turbine has logically been followed by an extension of the powers of the centrifugal pump, until now the indications are that the combined high-speed steam turbine and centrifugal or turbine pump will eventually supersede the ordinary reciprocating steam pump for many purposes. The centrifugal pump, in its simple form, is, of course, a very old machine, but it has been made effective for working against high heads only since the development of the modern steam turbine. In view of this advance and the meagerness of the published data on the subject the report of the recent tests made on three De Laval turbine pumps by Professors James E. Denton and William Kent at the works of the De Laval Steam Turbine Co., Trenton, N. J., is of considerable interest. Two of the pumps were driven by steam turbines and the third was operated by an electric motor. One of the turbine-driven pumps was single-stage and the other was a double-stage machine; the motor-driven pump was single-stage. The objects of the tests were: 1. To determine the efficiency of the pumps, expressed as a ratio of the water horse power to the brake horse power of the steam turbines driving them. To determine their economy in millions of foot-pounds per thousand pounds of commercially dry steam. 3. To provide means for determining the economy of the electrically-operated pump.

No. 1 pump was a single-stage centrifugal machine designed to lift 1,700 gallons of water per minute against a head of 100 feet when running at 1,545 turns per minute. It had 8-inch suction and discharge pipes and the runner was 13.75 inches diameter. It was driven by a 55-horse power De Laval steam turbine with a speed reduction of 10 to 1. It was found that the water horse power was at a maximum of 44½ horse power when delivering 1,760 and 1,860 gallons per minute at lifts of 100 and 95 feet, respectively. The efficiency of the pump to the brake horse power of the steam turbine ranged from 0.743 to 0.756 for delivery between 1,398 and 1,860 gallons per minute. The duty of the pump when running condensing ranged from 60,000,000 to 61,860,000 foot-pounds per 1,000 pounds of steam within the same limits; the duty decreased to 54,470,000 foot-pounds per thousand pounds of steam when the delivery fell to 1,001 gallons per minute against a head of 126 feet. The steam consumption per brake horse power when running condensing ranged between 24.06 and 24.53 pounds for deliveries between 1,398 and 1,860 gallons per minute.



Industrial Press N. Y.

Diagram showing Results of Tests.

No. 2 pump was driven by an electric motor of 20 horse power, and was designed to lift 1,200 gallons per minute against a head of 45 feet when running at a speed of 2,000 turns per minute. The suction and discharge pipes of this pump were also 8 inches diameter. The tests showed a delivery of 790 to 1,403 gallons per minute, working under heads of 59 and 30 feet respectively. The efficiency ranged from 0.714 for the maximum delivery of 1,403 gallons, to 0.750 for a delivery of 1,133 gallons. The efficiency fell to 0.683 for a delivery of 790 gallons per minute against the maximum head of 59 feet. The maximum electrical horse power or a brake horse power of 17.72 was attained at a delivery of 986 gallons per minute against a head of 53 feet. These heads also include suction lift.

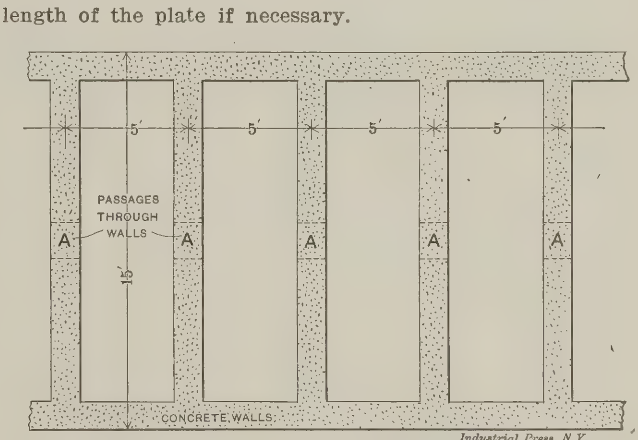
The third pump tested was a two-stage machine having runners 9 feet and 2.84 inches diameter respectively. This pump was designed to lift 250 gallons per minute against a head of 700 feet with the large runner turning at the rate of 2,050 revolutions per minute and the small one at the rate of 20,500 revolutions per minute. The small runner is connected directly to the turbine shaft and the large one to reduction gear shaft.

The two-stage, or compound pump, showed a delivery of from 244 to 373 gallons per minute against heads, respectively, of 781 and 136 feet. The water horse power increased from 12.83 horse power, corresponding to 373 gallons delivered at 136 feet head, to 48.15 horse power for 244 gallons delivered at 781 feet head. The duty in million foot-pounds was a maximum of 48,880,000 for delivery at the highest head and decreased to 41,550,000 for 328 gallons delivery at 494 feet head, and to 18,630,000 for the maximum delivery of 373 gallons at the head of 136 pounds. The steam per water horse power per hour ranged from 40.5 feet for the maximum horse power and highest head to 106.2 pounds for the maximum delivery, lowest head and lowest horse power. This lowest horse power is only about one-fourth of the highest horse power delivered by the pump. Both the electrical and two-stage pumps therefore realize their maximum efficiencies at practically the designed conditions of lift and water delivery.

* * *

LONG FLOORPLATE AND CONCRETE FOUNDATION.

Provision was made in the new addition to the Stilwell-Bierce & Smith-Vaile Co.'s plant at Dayton, Ohio, which was completed last year for a cast-iron floorplate 200 feet long and 15 feet wide along one side of the main section. Some of the horizontal hydraulic turbine settings built by this concern have been 130 feet long when connected up; it is desirable, and the practice generally followed, to connect all these settings and turn them over preliminary to shipping. For this reason an abnormally long and narrow plate was desirable as ordinarily two or more settings could be accommodated at once on such a plate, and one of the extra long ones up to the length of the plate if necessary.



Industrial Press, N.Y.

Plan of Concrete Foundation for Floorplate.

The floorplate is built up of cast iron sections, 15 feet long and 5 feet wide, laid crossways on the foundation. Each plate is planed on the top and sides and has four longitudinal T-slots which are also finished at the same time. The T-slots are one foot apart, and the sides are planed so that two adjacent plates form a T-slot between them. The thickness of the plates, which are in box section, of course, is one foot. Perhaps the most novel feature of the floorplate, however, is the foundation. The new shop was built on low ground and considerable filling was necessary to bring the floor level to the required height. Advantage of this condition was taken in the building of the floorplate foundation to provide easy means for leveling it up from underneath. Instead of filling this portion with earth, a concrete wall was built in cellular form, as indicated in the accompanying sketch, the distance center to center of the cross walls being 5 feet, and of the side walls over all, 15 feet. Each plate, therefore, is supported all around on its edges by the concrete wall. Openings are provided through the cross walls so that the underside of any plate is accessible at any time, and should settlement take place at any part, rendering lining up necessary, it can be accomplished by two or three men in short order and without disturbing the machines that may happen to be standing on it at the time.

* * *

In connection with the note recently published on the various uses of skimmed milk, in which mention was made of its use in making a primitive paint, we have been apprised of the information that Portland cement mixed with milk makes a very durable and excellent paint. Three pounds of cement are used to a gallon of milk; the mixture is colored with the desired pigment the same as oil paints.

ELECTRICALLY-DRIVEN PORTABLE TOOLS.

DR. ALFRED GRADENWITZ.

The use of portable tools is advisable and even indispensable in many cases when large and heavy pieces are to be worked or when the design of stationary tools does not allow of the piece being worked to advantage.

The electrically-driven portable drills illustrated herewith were made by the Elektricitats-Aktiengesellschaft vorm. W. Lahmeyer & Co., Frankfort, a/M. These drills may be placed in any position and at any height without regard to the source of power, and the use of variable speed motors allows the speed of the drills to be varied readily by steps. The operation of the drills by means of an electric motor may be effected in two ways, according as the motor with its accessories is either placed on a car and connected to the working machine by means of an adjustable shaft, or else the motor is an integral part of the tool itself.

The adjustable shaft connecting the motor with the drill is provided with two universal joints, and the middle section between the two joints is composed of two pieces—one of which slides within the other. These two pieces are splined and provided with a feather, so that the shaft may be lengthened or shortened. In Figs. 1, 2 and 4 some instances are given of this design, while in Fig. 3 is represented the type in which the motor is attached to the drill.

The mechanical part of the drills represented in Figs. 1, 2 and 4 was built by the firm of H. F. Stollberg, Offenbach. These machines have a vertical column on which a casting for supporting the radial arm of the drill can be adjusted and clamped in any desired position. The drill itself is carried by an arm sliding in this casting. This arm is bored out to receive the driving shaft, and power is transmitted to the drill spindle from the end of this shaft by means of bevel gears suitably inclosed for the protection of the workman. Adjustment of the drill upon the vertical column, and of the radial arm, is in some cases effected by threading the column and the arm and using a large nut which is turned by hand; in other cases by simply sliding one within the other without mechanical means of adjustment.

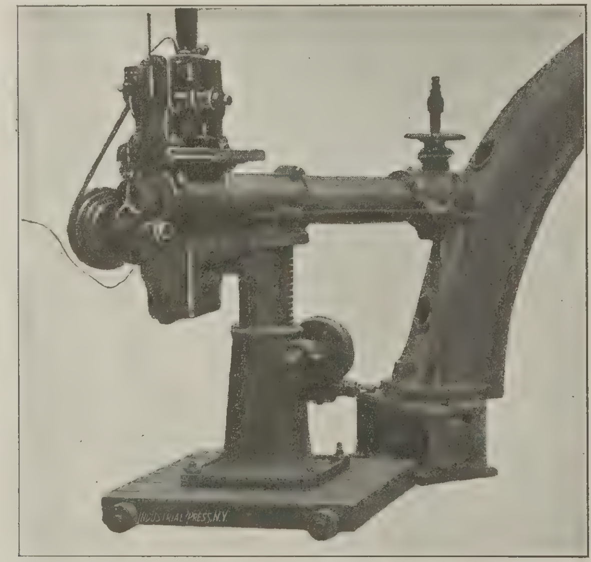


Fig. 9. Drill shown in Fig. 2 on Opposite Page.

The arrangement of the motor on the car is shown in the engravings. The car body is of cast iron and the motor is inclosed by means of a tightly fitting cast-iron cover. The car carries a reel for a coil of insulated wire for transmitting current from the nearest electric socket. As shown in Fig. 4 the handle bars can be removed when it is desired to suspend the motor, with its driving mechanism, from a crane hook.

In Fig. 3 is a small radial drill in which the motor is combined with the drill itself and drives it by a triangular belt running on cone pulleys. This drill was built in the machine shops of Lorenz, Ettlingen, Germany. It has a heavy base in which the column may be adjusted vertically by means of a worm mechanism and rack and pinion. The horizontal radial arm moves in a socket, which latter may either be clamped to the column or may swivel upon it, through a full circle. In the illustration, Fig. 9, on this page, the construction of the drill is shown more clearly. The drill head is at one end of the arm and swivels upon it, while the motor and cone pulley are upon the rear end. Fig. 10, on this page, shows the drill specially adapted for bridge building. It is driven from a portable motor by means of a jointed shaft and the drill weighs only 40 pounds, and may be easily transported to the working place by one man.

The drill head is supported by three legs, which at their lower ends have bell-shaped magnets with covered coils, by means of which the drill is kept in position electromagnetically on the piece to be worked. The legs are made adjustable, allowing the machine to be adapted to the conformation of the work to be drilled. After fixing the legs in position the drill may still be shifted in a vertical direction without changing the position of the magnets. The jointed shaft may be connected either directly to the drill spindle itself or to an auxiliary horizontal shaft geared to the spindle, and by this means two different speeds are insured, adapting it to holes of either small or large diameter.

Another drill of similar type is made by the Lorenz shops for drilling armor plate. This, in like manner, has the three legs, but the frame of the drill has a cross rail so that the drill head may be shifted laterally after the magnets have been fixed in position, thus making the machine adapted for drilling several holes in a row. In this case the motor is attached directly to the drill head, and has a safety switch which throws out automatically when there is an overload, thus preventing breakage of the drills.

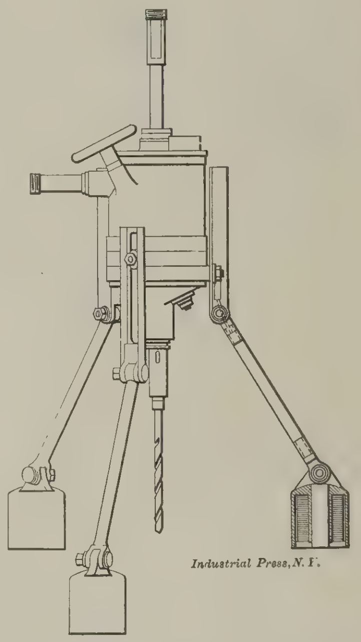


Fig. 10. Drill with Solenoid Tripod.

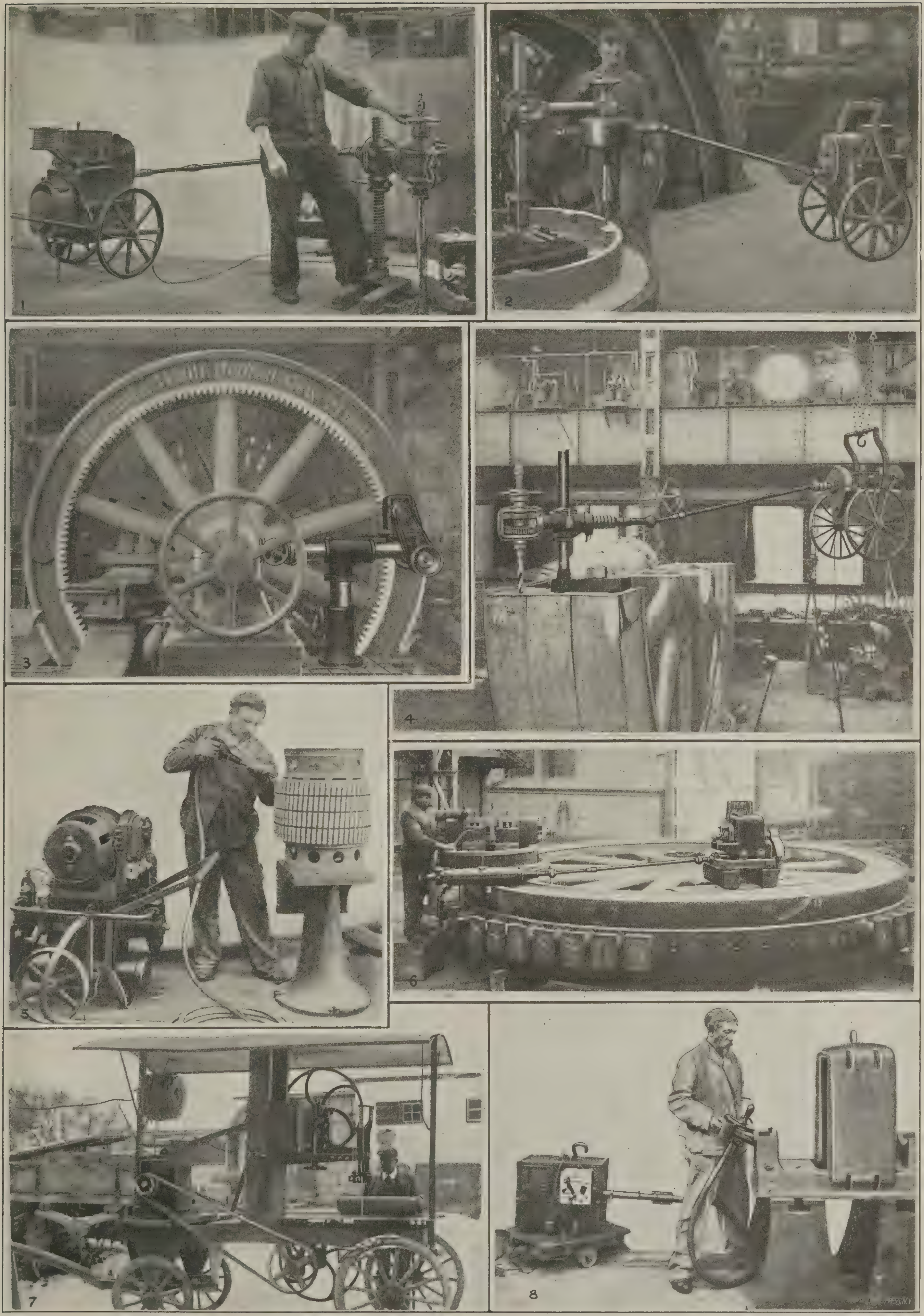
The use of compressed air tools as, for example, pneumatic hammers, chisels, etc., is being more and more widely adopted in Germany. In Fig. 5 of the group is a portable electrically-driven compressor of the Maschinenfabrik Aktiengesellschaft vorm Justus Christian Braun, for driving such tools. The compressor with its motor is mounted on a car of simple construction. The motor is a direct-current motor built by the Lahmeyer Co. The commutator of these motors is accessible through openings in the shield-shaped bearings, susceptible, however, of being closed. As the starting devices for the motor and the fuses are also located on the car, the whole becomes a homogeneous machine, requiring only hose connection with the compressed-air tools to be used anywhere. It is adapted to machine shop use with electric power transmission and renders tools independent of a special compressed-air plant.

In Fig. 6 of the group is shown a rotating device for turning ring-shaped grooves in flywheel rims over which circular rings are to be shrunk for holding the sections of the rim together at the joints. This is also driven by a jointed shaft from a portable motor.

Two more applications of portable tools are illustrated in Figs. 7 and 8. Fig. 7, though hardly a machine shop tool, is nevertheless of interest as being a convenient type of portable band saw which carries its own coil of wire for connection with the nearest available electric current. Fig. 8 is the familiar emery wheel and flexible shaft driven by a portable motor. The motor is thoroughly protected by a perforated metallic casing.

* * *

Pure iron does not exist in nature and so difficult is it to produce pure iron that some one has said that it may properly be classed as one of the "rare metals."



Group of Electrically-driven Portable Tools built by Foreign Firms. (See Opposite Page.)

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1904.

NET CIRCULATION FOR JULY, 1904,—21,611 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

THE MILL TYPE OF CONSTRUCTION.

The mill type of factory construction, which has been developed to its fullest extent in the immense cotton mills of New England, probably combines more features that are necessary or desirable for a manufacturing building than any kind of multi-storied structure. The only type that can be claimed superior in any respect is that embodying modern steel-concrete construction, with the steel covered by fireproofing material, and with re-inforced concrete floors. This type is more expensive, however, and it is not certain that it is any better than the regular mill type. Certain points embodied in mill construction are brick walls with large windows and pilasters to stiffen the walls; floors several inches thick, of plank, tongued and grooved together, with hardwood flooring laid on top; massive floor timbers, spaced widely apart, and left exposed, without any overhead covering; and rows of columns, preferably of timber, for the support of floor beams at the center of the building. Stairs, elevators, etc., must be in a separate brick tower, connecting with the main building by fireproof doors. Floors must be intact, with no openings through them. The automatic sprinkler must be in evidence and other means taken for protection against fire, and above all for fire prevention, following methods in these respects that have proven their worth in actual trial.

Mill construction, so called, is the result of a demand for a substantial structure at a comparatively low cost, with fire-resisting qualities of the first order, insuring protection to both products and machinery from damage by fire or water. In its most approved form it is a development that has come about through the efforts of mutual insurance companies, and it is rightly understood to comprehend a due regard to equipment and arrangement, with a view to reducing the fire risk, as well as a definite system of construction of the building proper. The features of strong, massive and simple construction are inseparably linked with the slow-burning and fire-preventive features in the modern mill type.

As a model example of what a mill type building can and ought to be, we are glad to present the description this month of the new plant of the New Britain Machine Company. The main building of this plant is as fully protected from fire dangers as it is possible, probably, for any building to be; its arrangement is convenient, it is well lighted and well equipped. Moreover, we think the description will be of rather unusual interest because the plant is of moderate size, like the majority of shops in this country, and so is more nearly representative of the average needs than a more imposing array of buildings would be. Descriptions of establishments of immense size, while of interest, are meaningless to the average person, because the average person does not expect to have the opportunity to become personally identified with such a plant.

* * *

The average American boy and grown-up only thinks of the elephant synonymous with the circus and pink lemonade; in India, however, the elephant is more highly regarded. It is a most invaluable labor-saving machine and one endowed with remarkable intelligence. The July issue of *Cassier's Magazine* presents an article "The Elephant as a Machine," accompanied with illustrations showing characteristic work for which these huge beasts are trained. The hauling of heavy machinery, building highways, piling lumber, treading clay for brick-making, are some of the uses to which they are put. The author says that the elephant appears at all times to comprehend the purpose and object that it is expected to effect; herein lies its superiority over the horse. The elephant voluntarily executes many details of its work with no guidance from its keeper. In moving a stone an elephant will step around and view the stone from either side and then adjust it with due precision, etc.

* * *

ASKED TO ANTE-UP.

The Massachusetts Institute of Technology is the largest, and one of the oldest technical institutions of learning in the country. Like other institutions, however, not blessed (?) with a heavy endowment, the possibilities in the way of extension by broadening and adding to the courses of instruction, enlarging the laboratories, etc., are always just a little in advance of the means at their disposal for doing such work. The institution, therefore, while maintaining the extremely high standard for which it is noted, is habitually in somewhat straightened circumstances.

At the same time a princely gift of $5,000,000 has recently fallen to Harvard University from the Gordon McKay estate, left by the noted inventor of shoe machinery, with the positive stipulation that it shall be used for technical instruction. Harvard has its scientific school, but it has been devoted to purely scientific subjects, in the main, rather than to instruction in the arts; and as it would seem like a waste of resources to establish a new technical school of great proportions so near the Massachusetts Institute of Technology, there has naturally come a discussion of the possibility of a union between the two institutions in some form or other, with a view to diverting part of the McKay funds in favor of the Boston school. The latter would then allow its students to avail themselves of the opportunities for scientific study at Harvard and would also receive Harvard students for instruction in technical subjects in return.

At a recent reunion of the alumni of the Massachusetts Institute of Technology, however, when the matter was extensively discussed, the sentiment among the past students was very pronounced as entirely opposed to any action of this kind. It was held that the Institute had acquired its own individuality, that there had been men associated with it who had stood for much in the industrial and scientific world, and that it was desirable on every account to preserve these characteristics and associations without regard to monetary considerations. Such a feeling for one's alma mater, akin, perhaps, to a feeling of patriotism, is a very noble sentiment to have, but it naturally has led the corporation of the Institute to wonder to what extent this expression of loyalty is the "real thing," and to what extent it is superficial and only for effect. In other words, they think it eminently proper that such exuberant expressions of feeling should be backed by hard cash and so each alumnus has been asked to step forward with a liberal contribution to ensure the future independence of the Institute. Sentiment is undoubtedly the greatest thing in the world—provided it goes deep enough to affect the pocket book.

AUTOMATIC SPRINKLERS ON SHIPBOARD.

The bits of wisdom that have been handed out by the technical and daily press on the question of safety in marine travel, since the burning of the ill-fated *General Slocum*, in which over 1,000 lives were lost, would, if gathered together, make a wonderful compendium. Machinery has even been the recipient of letters telling what "ought" to have been done and what "ought not" to have been done in the matter.

A contributor to the *Newark Evening News*, however, has made a suggestion which seems to indicate, at least, the direction in which safety for marine passengers is to be expected. He contends, in brief, that the same precautions and provisions against fire should obtain on sea as on land and what has proven effective means for the prevention of fire on land should be adopted on shipboard. One of these means is the use of the automatic sprinkler, and he believes it should be and can be applied on shipboard as well as in factories.

In another column we have called attention to manufacturing buildings of the mill type, which are of slow-burning construction. Such buildings have not come all at once. They are a development and are the result of the education of the public. In a manufacturing building, even of poor construction, there would be a hundred chances for the occupants to escape in case of fire where on shipboard there would be one chance. Yet the worst building of this kind is scarcely more of a fire trap than the flimsy superstructures on shipboard. While the latter are protected, to a certain extent, by fire-fighting apparatus, they are not provided with one-quarter the protection that is now considered essential in a modern manufacturing building, storehouse or department store. We do not believe that a change for the better can be brought about in a day; it must come as a development, through education, and it is about time that the insurance companies, government authorities and others of influence should start the primary course. As an illustration of the need of this, on the day following the burning of the *General Slocum*, a contract was awarded by New York City for five ferry boats to ply between Manhattan and Staten Island. The new boats are to have steel hulls, but the superstructure will be of wood —flimsy painted pine—designed substantially like the prevailing style for ferry boats. How easy it would be to use instead a light steel superstructure and to equip the vessels with automatic sprinklers. The trip that these boats have to make is a comparatively long one, and during the rush hours they will be as crowded as an excursion boat. It would seem as though the public which has to patronize this line would, in view of the dreadful lesson of the *General Slocum*, demand that safer boats be furnished them. Yet we have not heard of any such action being taken, and it probably will not be— because the public has not yet been educated.

* * *

TO EUROPE IN SIXTY HOURS.

When we wrote last month of the efforts of inventors to improve marine craft by circumventing the laws of displacement and friction, we did not know that an effort in this direction is in progress, almost within stone's throw of our office. None other than a hardy captain and mariner, who has sailed the seas for many years, is the inventor and he is now building a vessel which he describes as follows:

"The hull is divided in three sections, running lengthwise, with deep grooves between. Instead of plowing the water, as the ordinary hull does, having tons of resistance to overcome, these grooves allow the water to pass right through the hull, and the resistance is reduced to a minimum. Then I propose to have the propellers, three in number, in the forward part of the hull, instead of at the stern."

We do not think the captain has gone far enough. Cutting grooves through the hull will let only part of the water through. Why not cut away the hull entirely and let the vessel float on the surface of the bounding billow and draw as little water as possible? This would let the greatest possible amount of water "through the hull" and the captain would then have a raft—a type of vessel not noted for its speed, but which, according to his philosophy, should attain a wonderfully high rate of locomotion.

In talking about his invention, the captain says that the Deutschland, for example, if fitted with hull and propellers of his devising, would cross the ocean in half the time of her present average voyage and with a fuel consumption of 50 per cent. of her present cost for coal. The technical editor of the *New York Times* has gotten together some figures on this, however, which look a little discouraging. The Deutschland has a gross tonnage of 16,000. Her maximum midship section is about 1,936 square feet. Her indicated horse power is 37,500. Her best service record is 24.19 knots per hour. The distance between New York and Liverpool is 3,540 miles, or 3,070 knots. To make it in sixty hours the captain's boat will have to average about 51 knots an hour. To do this the Deutschland would have to be provided with 300,000 horse power of engines and burn approximately eight times as much coal as she now consumes per voyage. This is the practical side of the problem of the 51-knot speed. No doubt that speed is attainable for short distances in a specially-built boat in which carrying capacity and cost are of no account, but something more than a catamaran would be needed to float the engines and carry the fuel.

* * *

It is sometimes difficult to decide whether it is better to generate power in close proximity to the point where it is to be used, or to concentrate the power at a single point and then distribute it by some one of the methods of power transmission. Such questions frequently arise in respect to the use of power in mines or factories, but it is not often a point for serious consideration in a simple machine. Two incidents have come to our attention, however, in regard to the arrangement of the propelling machinery of an automobile where the question of power transmission is an all important one. Two inventors —and perhaps many more, though we have not heard of them —have been working independently in different parts of the country upon the same problem. They are trying to produce a steam automobile with engines acting directly on the hubs of the wheels, thus dispensing with intermittent gearing, universal joints, differential gears, etc. Both have adopted the scheme of using two three-cylinder motors, carrying the steam to them from the boiler located in the body of the vehicle. The advantages, of course, are those that accrue from direct driving and simplicity of parts; while the disadvantages, though less obvious, will appeal strongly to anyone who has had to do with questions of steam distribution. Steam has the habit of converting itself into water under any and all opportunities, and this act represents, usually, a lot of valuable heat units gone to waste. The place to condense steam is properly in a condenser, and it is not in accordance with modern methods to make a condenser out of an engine cylinder, and this principle evidently holds in automobile work as well as in any other. Two multi-cylinder engines, located where they will catch all the air that blows, and connected with the boiler by long pipes, would make ideal condensers, but scarcely an ideal installation of steam machinery, judged by general principles. The idea of locating the power next to the work in an automobile is not a bad one, provided the power is of the right kind. It will be remembered that an electric automobile truck having this feature was illustrated in the last number of Machinery. But here the case is different. The losses from subdivided electric power are small, and the losses from transmission are almost nothing.

* * *

One of the drawbacks of country life to those who are accustomed to the conveniences of city life, is the lack of running water in the house. This means no bathroom, a limited supply of hot water, and no water under pressure for sprinkling, etc. A tank in the attic is a source of danger from freezing and flooding the house, and is generally objectionable. Compressed air, however, has solved the problem, and made possible a water system in the house in isolated communities. A closed tank is buried in the ground and connected to a force pump driven by power, usually a wind-mill. The imprisoned air in the tank compresses and maintains a pressure on the water sufficient to force it into all parts of the system, giving it a head due to air pressure instead of coming from a higher level.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A recent patent, says the *Mining Reporter,* covers a novel use for copper in the manufacture of an anti-fouling ship's paint. The surface to be treated is coated with a quick-drying paint and finely-comminuted copper is blown into it. This surface is burnished and a second application of still finer copper is continued until a surface of copper is obtained.

We have no doubt that many draftsmen will be interested in the way blueprints are (not) made, as intimated in a story in the June issue of the *Ladies' Home Journal.* The hero visits an architect's office with his rough plan of a house, and finds that the architect is already committed to nine, "of which an amazing number of young men were drawing the details in white ink on sheets of blue paper!"

Hadfield's manganese steel is a unique product, says Mr. William Metcalf in a paper, "Alloy Steels," read before the June meeting of the American Society for Testing Materials. It is hard, tough, non-magnetic, non-hardening by quenching, non-annealable by any known method, and is practically unmachineable. It stands in a class by itself, for there is nothing to compare it to, nor to test it by. However, it is being used for a large number of special purposes.

A stone viaduct is being built at Plauen, Saxony, over the River Syra, which contains the longest masonry arch in the world, its length being 295 feet 3 inches, measured horizontally from base to base. The new bridge will be opened to traffic about November 1, 1904. The Luxembourg bridge across the valley of Petruffe, which was completed a few months ago, has a span of 277 feet. The next longest masonry arch is in the United States, near Washington, D. C., and is known as the Cabin John bridge. Its length of span is 220 feet.

An instance of a great invention being made and allowed to drop into obscurity to be reinvented later, is, incidentally, mentioned by Mr. Andrew D. White in the July *Century.* More than forty years ago, while with friends examining curios in the Imperial Museum at St. Petersburg, they found among the relics of Peter the Great, a lathe for turning irregular shapes and another for copying reliefs. These machines had been built for Peter by some ingenious mechanic from Holland fully one hundred and fifty years before and perhaps one hundred years before the date of Blanchard's famous invention.

The United States consul at Frankfort, Germany, says that aluminum is being quite successfully used in some of the foreign textile mills for making bobbins, in place of wood, which has been almost universally used for that purpose heretofore. Wood being very hygroscopic, gives more or less trouble in the spinning room on account of changes of weather which causes the wooden bobbins to run irregularly. The aluminum bobbins run smoothly in any weather and they are much lighter, five aluminum bobbins weighing about the same as two wooden ones. This difference in weight is said to make quite a difference in the economy of operating textile machinery as considerably less power is required for the production of the same amount of cloth with the lighter bobbins.

A great deal of thought and effort have been expended upon the recovery of tin from the vast number of tin cans and the tons of tin plate scrap that are annually rejected. Mr. John B. C. Kershaw reviews a number of the processes in the *Electrical Review.* The Germans lead in this work and may be said to almost monopolize it. They have eight factories which treat tin scrap electrolytically and reduce about 30,000 tons annually. Much of the tin scrap of this country goes to Germany and in 1898 it brought as high as $5 a ton in New York. Tin scrap contains on the average 3.5 tin and 96.5 iron. The great drawback to the successful prosecution of this enterprise is the large proportionate cost of collection and freight.

In a paper read before a Scottish mechanical society in Aberdeen, the assertion was made that mineral or vegetable oils should never be used on leather belting. Castor oil soon causes leather to rot and waste away, but linseed oil is excellent to use on cotton belts as it soon oxidizes and gives the belt an elastic gummy driving face. Leather belts should be treated with fish oils and animal fat mixed to the consistency of a soft ointment, which should be spread on both sides of the belt with a broad brush. A belt so treated can be made to transmit its maximum driving capacity without slip while running slack, and running in that way the trouble of hot bearings and overstrained belts is avoided.

In the April, 1901, issue a large lathe for turning granite columns was described, which was specially built for one particular job—that of turning the 130-ton columns for the cathedral St. John the Divine on Morningside Heights, New York City. In the description, it will be remembered, the statement was made that the cathedral had been building several years and that many more would elapse before it was completed. As an indication of the length of time that will probably elapse, it is interesting to note that the first of the granite columns was just erected, June 27. The original plan of making the columns monoliths was abandoned on account of the difficulty of turning such long heavy masses in the lathe, and they were finally made in two parts, weighing about 90 and 40 tons each.

The temperature of combustion of nitro-glycerine compounds or powders containing a large proportion of nitro-glycerine is said to be higher than the fusing point of steel. Hence the deteriorating effect of such powders on the bores of heavy guns. At each discharge a thin layer of the bore is actually fused and carried away with the discharge, which accounts for the rapid erosion of guns using such powders. The temperature of the nitro-cellulose used by the United States Government is considerably lower than that of the nitro-glycerine compounds, and consequently the erosion of our guns is much less than of British guns for the same number of discharges. For this reason perhaps more than any other the British Government is abandoning the use of nitro-glycerine in favor of nitro-cellulose.

At a recent meeting of the North Staffordshire Institute of Mining and Mechanical Engineers Mr. William Lockett read a paper describing the failure of a "lock-coil" winding rope 1¼ inches in diameter, 1,460 feet long, weighing 5,880 pounds and having a theoretical breaking strength of 156,000 pounds. The average load carried by the rope when hoisting was 12,500 pounds. Six broken wires were found in one place and five in another, but fortunately the defect was discovered before an accident occurred. Owing to the peculiar construction of lock-coil wire rope the author intimated that the outer strands, or those forming the lock-coil, were subjected to a greater stress than those forming the core, there being, it is believed, a lack of the mutual grip of the strands as found in ordinary wire rope. Another fault found with the construction is the difficulty, which amounts to a virtual impossibility, of lubricating the inner wires.

A funny tale comes from the South, according to the *Electrical Review,* telling of the sad experience of a telephone subscriber who attempted to repair his transmitter. Finding some difficulty with his telephone, this self-appointed repair man undertook to put it in order, but not with entire success, for upon taking apart the transmitter, the granulated carbon was spilled upon the floor and some lost. An examination of what was left convinced the would-be expert that the grains were nothing more than gunpowder. Consequently, when putting the instrument together again, he used gunpowder to replace the lost material. After finishing the job to his satisfaction, he attempted to call up the exchange, so that he might ascertain how successful his work had been, not thinking that now his transmitter was loaded; but, upon ringing the magneto, the gunpowder in the transmitter exploded, with some damage to the subscriber's face, and disastrous effects upon the telephone.

A New York patent firm has passed into the hands of a receiver, and in the application made to the court it was asserted that the inventive genius of the country is waning. In 1901 the company made a lot of money, but in the year following, the fertility and inventive genius of the country seemed played out, and there were but few really commendable and money-making patents filed in Washington. While it may be true that there has been a marked falling off in the number of good patents granted during the past two years, it can scarcely be consistently held that this diminution is due to lack of inventive genius. It is more likely caused by the general tightening up of money affairs and the falling off in trade. The most profitable patent business is that of large concerns developing new machines and processes, and these concerns, of course, do not take out as many patents when they are doing a small amount of work as they do when a great deal of new business is coming to them.

The United States consul at Birmingham, England, reports that some of the tube-making mills in his district are being "Americanized," skilled tube makers having been imported from Pittsburg and vicinity to reform the British system of tube making. The consul remarks that the men are brought over under five, three and one year contracts at wages several times greater than the ordinary wages paid in the Birmingham district, and at an advance over the wages paid for such labor in the Pittsburg district, but that there are some disappointments in store for them. In the first place the common impression abroad that living is cheap is erroneous—that is, on the scale to which the average American workman has been accustomed. Food and clothing are dearer than in the United States, and it is difficult to find houses with modern conveniences for rent that are within the reach of the imported workmen and near the works. Moreover, the imported men have to pay a good big income tax—something that they had not calculated on when accepting the job.

A scheme, undoubtedly new to many, for the delicate statical balancing of armatures and other revolving parts, is illustrated in the July issue of the *Electric Club Journal.* The shaft supporting the armature is not laid directly upon the balancing ways, but is encircled with a hardened steel ring at each end, which has been accurately ground and polished. The shaft and the rings roll together upon the ways, and, although these rings do not fit the shaft, they make the balancing test perceptibly more sensitive. When a soft steel shaft carrying a considerable weight is laid upon the balancing ways, there is some local deformation at the points of contact that tends to make it lie in whatever position it happens to be. With the hardened rings around the shaft this local deformation is largely neutralized; the rings being hard do not change shape so much as a steel shaft in contact with the ways, and the shaft itself bears on the inside of the rings where it is supported by a considerably greater area of contact, even when the rings are two or three times larger than its diameter.

The legend, "Patented September 18, 1894" (or any other date) stamped on any device or machine, gives little intimation of how broadly or how narrowly the principle is covered. Very few patents cover broad principles of operation or construction, and many patents are granted for ideas centuries old but modified, perhaps, to suit new conditions or thinly disguised to fool the examiner. A case in point is a spiral conveyor for carrying grain, granular matter or liquids, which is being exploited as a patented device and one superior to the ordinary type of screw conveyor, having a stationary shell and a revolving worm. The "new" conveyor consists of a pipe forming the shell, having a shallow internal flange riveted in a spiral. As the pipe revolves the contents are traversed in the direction of the lead of the spiral. This, of course, is essentially the Archimedean screw (without the central shaft), familiar to every school boy who has studied physics, and confessedly as old as Archimedes (212 B. C.) and probably much older. Nevertheless, it is a good idea and probably will prove valuable for the purposes designed.

In its description of the new White Star steamer, the *Baltic*, the *Scientific American* states that it is the first mercantile vessel to be equipped with the safety indicator used in the British Navy to show the approach of other vessels and thus prevent collisions. This device is placed on the bridge, and it indicates the exact position of any other vessel entering its magnetic zone. There is a dial carrying a needle on its face similar to a compass. As soon as the other vessel enters the magnetic zone, the radius of which in this instance is five miles, the needle revolves and points directly toward it, thereby indicating its precise location. This apparatus is highly sensitive, and even the screw revolutions of the approaching vessel are registered by the wave vibrations. In this manner the officer on the bridge can estimate the exact line he is distant from the other vessel, and act accordingly so as to clear it. With this precautionary device it is absolutely impossible for another vessel to creep up even in foggy weather or under cover of darkness without the officer being aware of its approach.

The *English Mechanic* says that a new instrument for measuring areas consists of a plate of glass on which are engraved a dozen or so graduated lines radiating from one center, the outer lines lying at an angle of 40 degrees. If any closed figure, such as an indicator card, be placed so as just to touch each of the outer lines, all the other lines will cut the figure at two points, and the sum of the interior readings subtracted from the sum of the exterior readings will give the area in square inches of the figure. Tested on a circle and on a triangle (equilateral), the errors did not exceed 0.07 and 0.02 per cent., and the error with indicator diagram is less than the error of the indicator itself. This convenient and cheap substitute for the planimeter was exhibited at the Royal Society soirée by Mr. R. W. K. Edwards.

Another device for the same purpose, designed by Prof. D. A. Low and sold by Longmans, Green & Co., consists of a piece of transparent celluloid printed with ordinates and abscissæ which are numbered. The use of this instrument is apparently not nearly as simple as that of the foregoing and cannot be intelligently explained without the use of diagrams.

Proprietary rights in trade marks are often exceedingly valuable, but the status of trade marks is often very vague and unsatisfactory. For instance, it is a department ruling that a trade mark shall not express a quality. That is, for instance, "Neverleek" could not be used as a trade mark for tinware as it would convey to the buyer an impression of quality which in all probability it could not possess. Hence the department refuses to sanction proprietary rights in descriptive trade marks. But trade marks have been issued which do unquestionably convey the impression of some desirable quality, which is an indication of the uncertainty of the regulations. Again in the United States, we do not hold that the mere use of numerals or letters in any particular order can properly constitute a trade mark, unless blended together in some arbitrary design. A recent consular report from Birmingham, however, gives an instance where the sole use of the letters "B. S. A." by the Birmingham Small Arms Company is upheld in a German court in opposition to its use by a German concern who were applying the same combination of letters to a line of cycle fittings, accessories and component parts which had no resemblance to the goods manufactured by the plaintiffs. The defendants are restrained from using "B. S. A." under penalty of $357 or imprisonment for six months for each violation, and had to pay all costs besides putting up a bond of $3,570 to secure the proper observation of the terms. This is believed to establish an important precedent.

Compressed air for the transmission of power has a field peculiarly its own, which probably it will always be able to hold against all comers, *i. e.*, the working of quarries and mines, and wherever the use of reciprocating tools is advantageous. But many compressed air plants have been installed giving an undeniably low efficiency for the coal burned under the boiler. One fruitful cause of loss is taking the air supply from the engine room, where the temperature may be 30 or 40 degrees higher than the external air. When it is considered that every 5 degrees increase of temperature of the air supply means, approximately, a loss of 1 per cent. in efficiency of air compressed it would seem that this cause of loss would always be avoided, but strange to say it is not. In addition to taking the air supply outside the engine room it is possible to go a step further and cool the air before it enters the suction pipe by circulating it through running water. The *Engineering News* gives a description of the compressed air transmission plant of the Cleveland Stone Company in which this is done. Air washers are placed at the mouths of the intake pipes to serve the double purpose of cooling the air and removing all dust and grit. Each washer contains 600 vertical pipes set in a box or tank with their lower ends immersed about 2 inches in running water. The intake air is drawn through the tubes, down through the water which is constantly changing. Not only does this remove the dirt and cool the air but it removes a considerable portion of the water or vapor in the air, because as air is cooled its capacity for moisture is reduced. The consequence is that no trouble from freezing of drills or motors has been experienced in this quarry even in the coldest winter weather.

CARBON VS. METAL BRUSHES FOR DYNAMOS.

A writer in the *Electrical Review* (London) asserts that the one redeeming feature of the carbon brush for dynamos is its non-sparking tendency, which, in his opinion, does not compensate for its bad features. The carbon brush practically necessitates large commutators and extra expense of brush gear, large shafts and longer machines, and therefore, must increase the cost of production by a large amount. Especially is this the case where large currents have to be dealt with. This practice results from the designer's doubt of the efficacy of metal brushes. Carbon brushes not only increase the first cost, but lower the efficiency, so that it frequently happens that this might be increased 2 or 3 per cent. by the use of metal brushes. Consulting engineers demand carbon brushes, unmindful of the fact that so long as sparkless commutation is secured it is immaterial of what the brush be made. Comparing the design of a commutator for a six-pole 88-kilowatt parallel-wound armature for carbon and for metal brushes it is found that the use of carbon necessitates three times as many brushes as the metal. For the former the commutator must be 17 inches long, and for the latter only 6. The watts lost, due to the friction of the carbon brush, number 1,025, as against 205 for metal. The watts lost, due to the resistance of contact of the former, are 1,260, as against 434, making the total loss 2,285 watts for carbon and 639 for metal. The watts lost per square inch are 2.51 for carbon and 2 for metal. The commercial efficiency with the carbon brush is 91.8 per cent.; with metal, 93.4 per cent. The chief virtue of the carbon brush is its high specific resistance, which facilitates sparkless commutation. To secure a similar condition with metal brushes they may be subdivided with an insulating partition between the portions; or the central layers of metal may have a higher specific resistance. Where a reversible motor is employed a radial brush is necessary, but it would not be impossible to construct a satisfactory brush of this type out of metal.

THE ACETYLENE SAFETY STORAGE SYSTEM.

Railway Critic, July, 1904, p. 180.

The recognized advantages of acetylene gas as an illuminant make the discovery of a safety storage system one of great general interest, especially to railway and steamship companies. The reasons for preferring acetylene as an artificial illuminant may be briefly stated as follows:

1. The quality of the light is more nearly like sunlight than any other artificial illuminant. It is not only specially adapted to interior illumination, but gives the most satisfactory results in running lights, as well as in searchlights of high power and penetration.

2. The quantity of acetylene ordinarily used in a gas jet is one-tenth that of an ordinary burner used with the best city gas, and with fifty per cent. more candle power. For example, an ordinary burner with the best city gas consumes not less than 5 cubic feet per hour and gives 24-candle power; whereas, the burners generally used with acetylene consume one-half of one cubic foot (one-tenth of the quantity), and give 26-candle power.

3. It is safer than any other form of lighting, because of the small quantity used. A jet carelessly left open would not emit enough gas, even in a small room during an entire night, to cause asphyxiation or to produce an explosion. The strong pungent odor of acetylene will instantly make apparent any leak that may occur.

4. The small quantity of gas burned (one-half of one cubic foot per hour) makes a small compact flame which cannot be blown out, even in a gale of wind, and which therefore can be used out-of-doors as readily as an electric lamp. At the Pan-American Exposition at Buffalo, N. Y., in 1901, the outside of an entire building was decorated with acetylene jets, which burned in the open air in all kinds of weather, and which were not affected by gales or rain; while their great brilliancy added perceptibly to their decorative effect in comparison with the adjoining buildings, the exteriors of which were decorated by electricity.

5. Until recently, acetylene has been used only in direct connection with generators, the use of which is objectionable on account of the space occupied. Notwithstanding this a large number of European yachts, both sail and steam, and other marine craft have already adopted acetylene. In England many of the steam yachts have thrown out their electric light plants and substituted acetylene as a matter of convenience and luxury; and as a matter of economy, a large number of the English Channel fishing fleet are using acetylene instead of oil.

The system which has already been successfully introduced in this country by the Commercial Acetylene Company, has two salient features; first, the use of porous brick or asbestos with which the tanks are filled, and which insures absolute safety; and, second, the use of acetone in combination with the acetylene. Exhaustive experiments in France, and also in this country, have demonstrated that when acetylene is compressed in a tank that has been previously filled with porous brick, asbestos or other porous substance, it is impossible to produce explosion even when an electric spark takes place inside the tank filled with acetylene under high pressure. Hence the introduction of porous brick or asbestos renders this system the safest in use. The pressure employed in ordinary practice is about one-seventh of the pressure to which the cylinders or tanks are subjected under test. The margin of safety is therefore greater than in any steam boiler in use, and leakage or explosion is a practical impossibility. The second feature of this system is the combination with acetone, a well-known, harmless and inexpensive drug, common in commercial use. By extended scientific experiments it was discovered that by saturating the brick or asbestos with acetone the capacity of a cylinder or tank of a given size and under a given pressure is increased tenfold. Hence the ordinary railway car cylinder (10 feet 4 inches long by 20 inches diameter), having a normal interior capacity of 22 cubic feet, will hold 220 cubic feet of ordinary city gas at 150 pounds pressure; whereas, when charged with brick and acetone, this same tank, with the same pressure, will hold 2,200 cubic feet of acetylene. Such a tank would contain sufficient gas to supply an ordinary railway car from New York to San Francisco and back four times without recharging; whereas, with the gas in common use, the same tank would require recharging every day or two, en route. Two or three such tanks of light weight would occupy insignificant space, and would supply a large sailing ship with ample light for one year without recharging.

The work of piping for acetylene is very simple. Inasmuch as the quantity of acetylene required to supply a given number of lights is one-tenth of the quantity required with ordinary gas, the size of diameter of the pipe used is very much smaller than the ordinary standard ⅜-inch gas pipe. A pipe of the diameter of a common lead pencil, or about the size of an ordinary insulated electric light wire, will be sufficient. This pipe is made of brass; and, where it is not practicable to conceal it, may be run in a cornice or molding in such a manner as not to be unsightly or otherwise objectionable.

The vitiation of the atmosphere by the consumption of oxygen is, of course, directly in proportion to the volume of acetylene used, and therefore about one-tenth as compared with an ordinary five-foot gas burner. The heat of an acetylene burner is also proportionate to the amount consumed. It has been estimated that an ordinary 16-candle power incandescent electric lamp gives out about one-eleventh of the amount of heat of a five-foot gas burner. As the acetylene burner consumes only one-tenth of the amount of gas consumed by a five-foot burner, the amount of heat given out by an acetylene burner is a very little more than that of an ordinary incandescent electric lamp.

ALLOY STEELS.

Abstract of Paper Read by Mr. William Metcalf before the American Society for Testing Materials at the Atlantic City Meeting, June, 1904.

Self-hardening or air-hardening steel derives its name from the fact that when it is heated to an orange color and allowed to cool slowly in the air it becomes exceedingly hard. Some years ago it was known generally as Mushet steel, from the fact that its first development was due to the distinguished metallurgist whose name it bore. The usual composition of this steel is about 2 to 3 per cent. manganese, 4 to 6 per cent. tungsten, and carbon high.

The distinctive, persistent hardness of manganese steel indicates that it is manganese that gives this steel its so-called self-hardening property. This was confirmed many years ago by Langley, who found that steel high in carbon, containing about 4 per cent. tungsten and minute quantities of manganese, had no self-hardening property, and that the same steel remelted, so as to contain 3 per cent. manganese, became an excellent self-hardening steel. Langley next showed by his beautiful emery wheel test that tungsten is the element that acts as a mordant to hold the carbon in solution at a high temperature, giving this steel its most valuable property, that of remaining hard at a comparatively high temperature, so that a tool made of it could be used for cutting metals at a high speed, the tool continuing to do its work at a temperature, caused by the enormous friction of the high speed, that would soften completely and render useless the best carbon steel tool that could be made. This very useful variety of steel has a large place in the markets, being used for many purposes where its peculiar properties give it great value. It is being rapidly overshadowed, however, by the latest and most surprising steel of all, known as "high-speed" steel.

Air-hardening steel, as a rule, is not tough—that is to say, if it is made tough it will not be very hard. The edge of a tool will flow, and when it is so hard that it will not flow then it is so brittle that it will crumble easily, and this limits its usefulness. A few years ago, at the Bethlehem Steel Works, some person—whether he was a blunderer or a genius history does not say—revolutionized the whole machine business. Either by design or accident he heated a tool made of air-hardening steel until it was nearly melted, and according to the traditions and teachings of the ages the tool was ruined utterly. Again, either by accident or design, this "ruined" tool was put into service, and to the amazement of everybody it did an unheard of amount of work. This led to further experiments and tests, and the Taylor-White process was developed.[*]

This process consisted in heating a tool excessively hot and cooling it by successive stages, producing a tool that would cut at enormous speed for metal work, and take off chips that developed enough heat to blue them. The process was patented, and therefore it is not necessary to go into a long explanation here, especially as it has been superseded. The process seems to have been uncertain—that is to say, when a tool was handled just right it produced results that were wonderful, and when the manipulations were not exactly right the results were *nil*.

The potentialities were so great that nearly all of the leading steel makers in the world attacked the problem, with the result that the present high-speed steels are in no sense of the words air-hardening. Manganese has been reduced from 3 to 4 per cent. to 0.30 per cent. to traces; tungsten has been increased to 10 to 20 per cent., instead of the usual 4 to 6 per cent., and the carbon is generally less than 1 per cent.

There are about 50 different brands on the market, and of course each one is the best. Perhaps the analyses of two of the leading brands will be interesting, as follows:

	Per cent.	Per cent.
Tungsten	9.99	18.48
Chrome	2.83	2.90
Carbon	0.69	0.78
Phosphorus	0.010	Not determined
Sulphur	0.010	Not determined
Silicon	Trace	Not determined
Manganese	Trace	0.33

Another contains the following:

	Per cent.
Molybdenum	9.65
Chromium	....
Carbon	0.66
Phosphorus	0.016
Silicon	0.046
Manganese	0.22

In one sense, it is chaos. All traditions as to heating are completely reversed, and no one really knows what is the best. One brand is famous for its excellence in one kind of work, another in another kind, no one yet seeming to cover all of the ground.

One thing is certain, the machine business is revolutionized. These tools have crowded ordinary lathes, planers, drills, etc., away beyond their capacity; machine builders are remodeling their machines to meet the new conditions, and many of the users are throwing out their old machinery for the new, or else remodeling and strengthening what they have. There are many records published of the work done by this steel, giving speed per minute, feed, depth of cut, etc., so that it is not necessary to repeat them here. A few illustrations of what can be done may be interesting:

In one case a couple of steel cast bedplates about 4 feet wide and 9 feet long were to be planed. There was nominally ½ inch to come off, but the unevenness of the casting made the cut about 1 inch in places. The surface was hard and gritty from the sand of the mold. Several tools were tried, each one going about ½ inch and then having to be reground. Next, one tool cut about 2 inches without grinding. Finally a tool was tried that had turned up a large, rusty, cast iron pulley without grinding, and it cut clear across the bedplates and was still in good condition for further work. It is clear that the cost per pound of that tool cut no figure.

Another party had a great many castings to thread. With dies made of the very best carbon steel, he could at moderate speed thread from 2,000 to 3,000 pieces without grinding; with dies made of high-speed steel, and with his machine running as fast as he could drive it, he threads from 20,000 to 30,000 pieces without grinding. Another party turns many pieces of hard brasses. He found it difficult to get a tool that would cut them at all until he tried the right high-speed steel, and made a tool that would cut all day without grinding, running his lathes at the highest speed he could get. The same party bores many cast iron cylinders, and with tools made of steel that would not cut his brass he bores eight to ten cylinders without regrinding, and at a speed so great that the cylinders came out too hot to be handled with the naked hand. He tried in his cylinders the steel that cut his brass so well, and it would only bore two to four cylinders without grinding.

Another party drills 2⅜-inch holes 7 inches deep in soft steel forgings, drilling a hole in about three minutes; the same steel will not make a good threading die for the same forgings, and for this he uses another brand. Neither of these steels will make a good lathe tool for turning these forgings, and for this work he uses a third brand.

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[*] Mr. White claims that the process of treating air-hardening steel known as the Taylor White process is the result of a series of tests made with the specific object in view. It had been discovered that overheating sometimes improved an air-hardening tool, but more frequently it was ruined so the tests were made to discover the critical temperatures.—EDITOR.

All of these brands, upon analysis, would come within the limits of the analyses given above. From all of this two things are clear: One is that there has been a marvelous, a revolutionary, advance in the machining of metals; the other is that steel makers have met the demand remarkably.

It is also clear that we do not know yet where we are and there is much to be learned by everybody. The best methods of hardening may not have been found; it seems that for very high speed work it is necessary to fairly melt the point of a tool and quench it in a strong air blast, and then grind to shape. This would not do for threading dies, milling cutters, etc., for the heat would destroy the tools. Such tools are finished from annealed bars; this high speed steel can be annealed as nicely as carbon steel, differing in this respect from air-hardening steel. The finished tools are heated in a lead bath of 1,800 degrees to 2,000 degrees, and are quenched quickly in ordinary tempering oil, which must be kept cool by a coil containing circulating cold water; they are then tempered in a bath of heavy oil heated to about 450 degrees. The tools come out bright and clean and do their work wonderfully well.

The steel maker has the most to learn. He must find out why there is such a great difference in the work the steel will do, when there is so little difference in composition. He must find the composition or mixture that will come nearest to meeting all the requirements. He has at his command now ferromanganese, ferrosilicon, ferrochromium, ferrotungsten, ferromolybdenum, ferrovanadium and ferrotitanium. These alloys are all expensive, except the first two, costing from 60 cents to $12 a pound; therefore the present prices of high-speed steel, which to some people seem to be of the fancy order, are really not excessive.

TABLE I. COMPARATIVE COST OF OUTPUT FOR ONE PAIR OF DRIVING WHEELS.

OPERATION.	Carbon. Hrs. Min.	Air Hardening. Hrs. Min.	High Speed		Carbon.	Air Hardening.	High Speed.	
			Hrs. Min.	Hrs. Min.				
Setting tool, etc., throughout job	1:30	1	:45	:36	$0.50	$0.33	$0.25	$0.20
Grinding roughing tool	1:30	1	:20	:20	.50	.33	.11	.11
Grinding flanging tool	1:30	1	:04	:04	.50	.33	.02	.02
Roughing cut	8	5	1:15	1:00	2.65	1.65	.41	.33
Finishing cut	5	2:30	:30	:30	1.65	.83	.17	.17
Flanging cut	2:30	1:30	:30	:30	.85	.50	.17	.17
Total labor	20:00	12:00	3:24	3:00	6.65	3.97	1.13	1.00
Interest, depreciation, repairs, etc., figured at 15% on first cost, per hour					.13	.40	.40	....
“ “ “ “ “ “ “ “ “ “ per job					2.60	1.60	1.30	1.20
Power, at 3 cents per horse-power hour, per hour					.07	.12	.18	..
“ “ “ “ “ “ “ per job					1.00	1.00	.50	.50
Total fixed charges					3.60	2.60	1 80	1.70
Total of all items					10.25	6.57	2.93	2.70

NOTE.—Since test was completed the average time and cost of turning drivers has been somewhat lowered, as shown by the second column under “High Speed” in each case.

As far as we know at present, the steel users have not succeeded in making tools that are satisfactory for finishing, and for this purpose they resort to tools of carbon steel, after having done the rougher, heavier work with high-speed steel. This difficulty may be overcome by proper methods of hardening and tempering, or the steel makers may find a composition that will make a tool that is as good for finishing as for roughing.

IMPROVED TOOL STEEL IN RAILWAY SHOPS.

Paper Presented by Mr. W. R. McKeen at the Annual Convention of the American Railway Master Mechanics' Association, at Saratoga Springs, N. Y., June, 1904.

The following tests of tool steels were not made on specially devised castings or forgings, nor were any machines arranged in special reference to these tests. All observations were made on work going through the shop during regular working hours and on actual locomotive parts being put through the shop, these same parts being afterward applied to locomotives. The tests were conducted according to the directions of the chemist and engineer of tests, and under the supervision of the general shop demonstrator; the electrical readings were taken by the local electrician, and the machines were handled in their regular course by the mechanics assigned to each class of work. Turning and planing tools were forged and tempered by the regular toolsmith, and the twist drill and milling cutters were made in the local tool room. Under these conditions a much fairer comparison as to the actual benefits obtained from alloy tool steel in regular shop practice can be made than where special conditions are followed.

Three lines of comparison were taken, namely: First, the speed, cut and feed; second, the durability of tools; third, the amount of power expended in keeping a tool up to its proper capacity. The first depends upon the volume of output; the second on the quality of steel and manufacturer's and toolmaker's skill; the third being closely related to the first and dependent on it. Throughout these tests the new alloy steels were compared with the old carbon variety. In tests 1 to 6 it is well to bear in mind that the air-hardening tools have been in the market for a number of years, and, roughly speaking, are a mean between the carbon steel and the alloy steel.

Tests 1 *and* 2. Roughing out side rods on planer; channel 1 by 4 inches by 4 feet 6 inches. The time of test indicates the cutting time of tool only, neglecting the reverse of planer, as well as the setting of work. The alloy tool kept its edge throughout the tests and was in condition to do two or three hours more work without regrinding, as shown in equivalent performances at other times. The regrinding was due, not to the cutting edge being destroyed, but to the hollowing out of top of nose of tool by surface friction of the metal removed. The time given as "time of test" was the actual cutting time required to rough out one channel of one side rod. The carbon tool, on the other hand, had its cutting edge completely burnt off at the end of three-quarters of a minute (two strokes of the planer), destroying the nose for half an inch, making any further cutting action impossible. Previous experience with the same kind of carbon tools on this class of work has demonstrated that in order to keep up the cutting edge of a tool (without regrinding, as with alloy steels) only one-half of the depth of cut could be maintained, as was taken in Test 2, removing then only one-half as much metal per hour as shown in that test, and increasing the actual cutting time to about 25 minutes. Comparing the time required by each tool for actual cutting, and for reverse of planer in each case, we find that the alloy steel tool will finish up one rod channel in 7½ minutes and the carbon steel tool in 40 minutes, a difference of over half an hour for each rod turned out. Two rods are ordinarily turned out at the same time; therefore the difference in time is about 16 minutes in favor of the high-speed tool for each channel cut.

Tests 3 *and* 4. Turning old and badly worn standard driver tires, 70-inch diameter. Table 1 shows that when considering the grinding of tools or interest on plant, the new steels are money-savers. A carbon roughing tool will require 15 minutes (walking to and from emery wheel, etc.), and each tool will ordinarily be reground three times for each tire turned; whereas the high-speed tool will last throughout the job with one grinding. In this table, showing comparative cost of output, it will be seen that there is not a single operation in which the new tools do not directly or indirectly effect a sav-

TABLE II. COMPARATIVE PERFORMANCE OF ALLOY AND CARBON STEEL.

MACHINE AND EQUIPMENT	METAL MACHINED.		Feed per Revolution. (Inches.)	Depth of Cut. (Inches.)	Speed. (Ft. per min.)	POWER TO RUN MACHINE.						Effective Horse-power for Cutting.		Metal. Removed. (Pounds.)		TOOL.					Total Longitudinal Feed. (Inches.)	Time of Test. (Minutes.)	Condition of Tool after Test.	REMARKS.
						LIGHT.			UNDER LOAD.							Size. Height-Width (Inches.)	Angle.			Kind of Steel.				
						Volt.	Amp.	H. P.	Volt.	Amp.	H. P	H.-P	% of Total.	Per Hour.	Per H. P. Hour.		Top.	Front.	Side.					
Planer, 60″x 60″x 30′	Soft steel side rods 4′ 8″ long cut.	1	¼	1	16	219	43.8	12.9	219 4	71 1	20 9	8	38	780	97 5	2½ x 1½	60°	80°	80°	Alloy	4	4¾	Very good.	Limit of machine
20 horse-power Westinghouse motor		2	3-16	½	16	219	43.8	12.9	212	56	15.9	3	19	288	92	2½ x 1½	60°	80°	80°	Carbon	⅜	¾	Burnt ½″	
Wheel lathe, 100″ swing	Old and badly worn Standard driving wheel tires, 70″ dia.	3	3-16	5-16	23	228	12	3.7	226	21.2	6.4	2 7	42	96	36	2½ x 1½	82°	78°	88°	Alloy	4	17	Very good.	
15 horse-power Westinghouse motor Gear driven.		4	3-32	3-16	6	226	6	1.8	228	7 6	2 3	5	22	15	30	2 x 1	82°	78°	88°	Carbon	¼	27½	Burnt up.	
Pond engine lathe, 42″.	Hard cast iron Cylinder. Bushing, 28″ dia.	5	¼	5-16	22	227	25	7 6	228	38	11 6	4	34	180	45	2 x 1	60°	80°	80°	Alloy	6	8	Good.	
20 horse-power Westinghouse motor. Countershaft.		6	3-16	5-16	11	228	24.5	7 4	228	32.6	10	2 6	26	54	20 7	2 x 1	60°	80°	80°	Carbon	4	14	Burnt up.	
Vertical milling machine. 10 horse-power Westinghouse motor.	Cast iron locomotive shoe.	7	00674	....	45	222	6	1.8	222	15	4.4	2.6	59	195	75	4⅛″ dia. x 3½″ face	......	......	......	Alloy	20	6	Very good.	
		8	00275	....	45	222	6	1.8	219	10.7	3.1	1.3	42	82	63	4⅛″ dia. x 3½″ face	......	......	......	Carbon	20	14½	Burnt.	
Radial drill. 3 horse-power Vertical Westinghouse motor.	Medium hard cast iron blocks, 5″ deep hole.	9	012	Mean 23-64	100	230	4.5	1.4	228.6	16.6	5.6	4 2	75	88	21	1 7-16″dia.	......	......	......	Alloy	6	1.50 sec.	Very good.	Limit of machine.
		10	.007	Mean 23-64	64	230	4 5	1.2	228.3	8.5	2.6	1.4	54	51	36 4	1 7-16″dia.	......	......	......	Carbon	6	2.55 sec.	Burnt	
Radial drill. 3 horse-power Vertical Westinghouse motor.	Soft steel cutter blanks, 4″ deep hole	11	012	Mean 23-64	100	230	4.5	1 4	222.9	16 1	4.7	3.3	70	88	26 7	1 7-16″dia.	......	......	......	Alloy	6	6	Very good.	Limit of machine.
		12	007	Mean 23-64	64	230	4	1 2	227	10.9	3.3	2 1	63	51	24 3	1 7-16″dia.	......	......	.....	Carbon	2	14½	Burnt ¼″	

ing in setting and grinding tools, varying from 50 per cent. to 98 per cent. of time originally taken with the carbon steels. These savings are real gains and not mere statements on paper.

To take up the table part by part: The first line shows time consumed in setting tools; where these tools have been taken out of the holder frequently for regrinding, etc., more time will be so occupied than when practically no resetting occurs. The grinding shows up clearly the comparative durability of the tools; the old steel requiring much more frequent grinding than the high-speed or alloy steels. While the flanging tool does not have such severe usage as the roughing tool, it requires much greater care in grinding. With the alloy tool one grinding of same will answer for about 15 wheels, or an average of four minutes for each pair of wheels. In the tests the flanging tool was of special design, being quickly ground to standard by tool room; the average time occupied for grinding per each pair of wheels being two minutes.

The next three items—roughing, finishing and flanging cuts—are the main economical features, and are entirely due to the high speed capacity of the new tools. It will be seen that the labor cost in the case of the high speed is only half that with the ordinary air-hardening steel, and less than one-third as much as with the old carbon steel tools.

The interest, depreciation, repairs and renewals to machine and electrical equipment have been estimated at 15 per cent. on $6,000 for the modern lathe, or 40 cents per hour, and at 10 per cent. on $3,000 for an old-style lathe, which would be sufficiently fast for the speed capacity of the old carbon steel tools. It must be remembered, in this connection, that there has as yet been no driving wheel lathe built expressly for high-speed alloy steels. [The author is mistaken in this statement.]

The power (delivered to work) has been taken in all cases at 3 cents per horse power hour, a conservative figure for conditions in the middle West, and considering the many transmission losses.

To summarize these features:

Planer Tests 1 *and* 2:—Alloy steel necessitated 20.9 horse power removing 780 pounds of metal per hour, as against 15.9 horse power with carbon steel and only 288 pounds metal removed per hour.

Wheel Lathe Tests 3 *and* 4:—Alloy steel necessitated 6.4 horse power with 96 pounds metal removed, as against 2.3 horse power with carbon steel and 15 pounds metal removed.

Lathe Tests 5 *and* 6—Cylinder Bushing:—Alloy steel necessitated 11.6 horse power and 180 pounds of metal removed, as against 10 horse power with carbon steel and 54 pounds metal removed.

Milling Machine Tests 7 *and* 8. Locomotive Shoe—Alloy steel necessitated 4.4 horse power and 195 pounds metal removed, as against 3.1 horse power with carbon steel and 82 pounds metal removed.

Radial Drill Tests 9 *and* 10. Cast Iron Blocks:—Alloy steel necessitated 5.6 horse power and 88 pounds metal removed, as against 2.6 horse power with carbon steel and 51 pounds metal removed.

Improved, or alloy tool steel has increased the output of railroad shop machines from 25 per cent. to 100 per cent., and in certain cases as much as 200 per cent., and while, with increased output, the horse power required to turn out work has increased, this increase of horse power absorbed is not in proportion to the increase in output. The use of alloy steel, where machines have been driven by motors already worked up to capacity, will necessitate 25 per cent. to 50 per cent. larger motors, as has been evidenced by our own experience.

The strength and capacity of our present machines are almost universally overtaxed, for the reason that they were not designed for the new conditions. Our experience has shown conclusively the necessity for heavier and more substantial design of all machines; steel pinions instead of cast iron; longer bearings for shafts and increased diameter of same, etc. Furthermore, it clearly demonstrates beyond the credulity of anyone the economy of scrapping old-style machinery.

Our best record on locomotive driving wheels is a 56-inch pair in 1 hour and 27 minutes. Steel-tired car wheels formerly required from 5 hours up to turn and true to size; the present minimum time in our shops is 55 minutes, the average being about two hours. While these reductions in time are largely due to the alloy steel, improved shop methods and system have also entered considerably into the economies mentioned.

STUDY OF VIBRATIONS OF A LOCOMOTIVE IN ACTION.

La Revue Technique, February 25, 1904, p. 48.

Herr von Borries, professor at the Charlottenburg Technical School, presented a paper to the German Society of Mechanical Engineers on October 13, 1903, in which he showed that the oscillations of locomotives due to the unbalanced weights of the engine, could be reduced to a rotative motion about a vertical axis passing through the center of gravity of the machine and a forward surging motion acting longitudinally. The amplitude of these oscillations can be calculated by rules that the author states very clearly.

In the case of a well-designed locomotive, where the balance of the reciprocating parts is properly proportioned by means of the counterweights, these oscillations are not sufficient to cause a dangerous disturbance of the locomotive. Their amplitude is limited and remains constant regardless of the speed of the engine. The amplitude of the swaying motion of a 4-4-0 high-speed locomotive is not more than 0.16 inch if 20 per cent. of the weight of the reciprocating parts is balanced.

Herr von Borries has designed a very ingenious model, that is described in his paper, by means of which he has shown very clearly that the oscillations due to forward surging and swaying are small and synchronize with those of the driving axle. The amplitude of these vibrations does not vary with the speed, so that from that standpoint there would be no danger in building an engine to run at a speed of 115 miles an hour. The generally accepted opinion, then, that these oscillations increase with the speed is erroneous. From this it appears that the rotation about the vertical axis that occurs in a locomotive as a result of the movement of the reciprocating parts, is confounded with the swaying motion of vehicles upon rails. This swaying motion has a much longer period of oscillation than the rotation of the locomotive. It is brought into being at a certain speed and increases rapidly. In order to differentiate between these two oscillations it is necessary to observe their periods and count the number of turns of the driving wheels at the same time.

When a locomotive is running the stresses due to forward surging must be taken into account. At high speeds they may become dangerous and may reach considerable proportions. In the case of a locomotive where the weight of the reciprocating parts for each cylinder is 660 pounds, of which 20 per cent. is balanced and with driving wheels 7 feet 2½ inches in diameter and the stroke of the piston 23½ inches, the surging movement produced, at speeds of 75, 95 and 115 miles an hour, corresponding to a speed of rotation of 4, 5 and 6 revolutions per second, becomes equivalent to a stress of 10,120; 15,840 and 22,880 pounds respectively. These stresses occur in opposite directions, twice for each revolution of the driving wheels. It must, therefore, be quite evident that these stresses, which are produced so rapidly in opposite directions, must have some influence upon the coupling to the tender. The stresses set up by surging are also not as inoffensive as might be supposed and their complete suppression is one of the principal advantages of the four-cylinder locomotive.

The resultant effects of swaying decrease as the wheel base is increased. The couple producing this motion has a lever arm equal to the spread of the cylinders, and they are resisted by one whose lever arm is the wheel base of the engine or the distance from the center of the bogie to the back axle, when the engine has such a truck. On the other hand, the couple which produces swaying is 70 per cent. of the stress which produces surging. In the case of four-cylinder locomotives and admitting that reciprocating parts of the engines weigh one-third less than in the case of the ordinary engine, the swaying action would be one-eleventh that produced by surging, at a maximum.

This explains why, with locomotives having a long wheelbase, the swaying motion is scarcely perceptible when there are outside cylinders and disappears entirely when they are inside or when there are four. It would seem, then, that recourse must be had to four-cylinder engines for high-speed service, since they are the only ones which do away with the effects of surging and, at the same time, annul those of swaying. From the standpoint of ease of motion and stress upon the roadway the electric motor possesses no advantage over the four-cylinder engine. G. L. F.

* * *

THE NEW WHITE STAR STEAMER BALTIC.

The new White Star steamer, *Baltic*, made the port of New York July 8, completing her first trip across the Atlantic. The building of the *Baltic* has wrested the palm from the *Cedric* and *Celtic* and she is now the one that is notable for being the largest vessel afloat—a statement that implies an immense size in these days of floating leviathans. This great ship, built by Harland & Wolff, Belfast, is 725.9 feet long, 75 feet wide and 49 feet deep and has a cargo capacity of 28,000 tons, or the equivalent of 700 railway cars of 40 tons capacity each. When loaded to her "Plimsoll" mark the *Baltic* displaces 40,740 tons of water, or about 1,420,000 cubic feet.

She has eight decks including the sun deck at the top of the superstructure, which is about 50 feet above the water at full lading. In the hold are the cargo and deep ballast water tanks, forward; coal, engines and boilers, amidships; and deep ballast water tanks and cargo, aft. The lower orlop deck carries cargo forward; coal, amidships; and cargo and meat chambers, aft. The orlop deck has meat chambers and cargo, forward; coal bunkers, amidships; and meat chambers and cargo, aft. The lower deck has meat chambers and cargo forward; crew and coal bunkers, amidships; and third-class passengers, aft. The middle deck carries the second-class staterooms and third-class mess room, amidships; third-class accommodation forward and aft of saloon. On the upper deck the crew is forward; first- and second-class staterooms and first-class saloon, amidships; and third-class smoking room, aft. On the promenade deck are the first-class staterooms, and second-class smoking room and library. On the boat deck are the first-class staterooms, and on the upper or sun deck, are the first-class smoking room and library.

The above somewhat lengthy category gives a meager idea of the immensity of this great vessel which has accommodations for 3,000 passengers and a crew of 350—enough to populate a good-sized town. The vessel has twin screws and the propelling engines are quadruple expansion, balanced on the Schlick system. In power the *Baltic's* engines are far below many of the other modern steamers, being only 13,000 I. H. P. She was not designed for speed, however, but is first of all a freight boat and after that a passenger boat for those who care more for comfort than a swift passage. The immense size of the hull and the provision for water ballast reduce the tendency to roll in a seaway. Besides she has bilge keels or rolling chocks that also materially deaden rolling action. The water ballast tanks in the double-bottom hold 6,500 tons of water so that with a light cargo the displacement may be maintained nearly equal to that with full lading. Powerful pumps are provided for filling or emptying the double-bottom quickly. In general equipment the *Baltic* has all that human ingenuity has been able to provide for safety and economy of operation. A safety indicator for preventing collisions with other vessels is a device never before applied to mercantile vessels, although in use in the British navy.

* * *

A writer in the *Foundry* apparently strains a point in trying to prove that Mr. Outerbridge's discovery, that cast iron can be permanently expanded by repeated heatings up to, say, 1,200 degrees F. (see April MACHINERY), also explains the alleged fact that the flatirons used for ironing "lose their temper" as they become old, that is, do not retain heat as well as new ones. The same condition is alleged to affect curling irons, an old curling iron not heating as quickly as a new one and losing its heat quicker. How much truth there may be in this alleged condition we are unable to say, but it seems scarcely reasonable or consistent that the expansion of cast iron due to the repeated heatings of "ironing day" can permanently expand the molecules of a flatiron to such an extent that the internal circulation of air could account for such a phenomena, as is advanced by the writer.

TOOL MAKING.—9.

HOLLOW MILLS.

E. R. MARKHAM.

In many shops hollow mills are used very extensively, while in others they are entirely unknown. It is a fact that in some shops they are used where other tools would serve the purpose better and at less cost, yet in the face of this they are valuable tools when rightly made, and used on work for which they are adapted. Formerly hollow mills were used much more extensively on screw machine work than at present, but observation has taught me that many of the leading manufacturers of high-grade work consider them an indispensable part of their equipment.

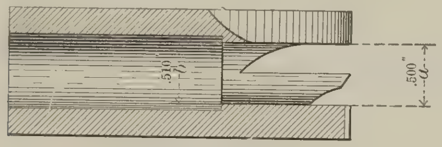

Fig. 1

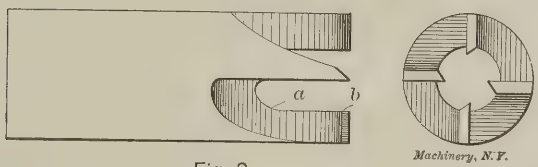

Fig. 2

Hollow mills are usually made from a good grade of tool steel, containing about 1¼ per cent. carbon. Experience has convinced me, however, that best results follow if steel containing a higher percentage is used, provided necessary care is taken when the tool is hardened.

The exact form of the mill and the method of making depend on the use it is to be put to. When used for roughing work, where exactness of size is *not* essential, there is no means provided for adjustment. If the mill is to be used for finishing at a comparatively light cut, and especially where exactness of size is essential, it is made adjustable. If the work to be done allows the use of a mill having inserted blades, and many mills of a size are to be used, this form is found the cheaper. When mills with inserted blades are used, the blades are generally made of high-speed steel, as much higher speeds can be used and the tool run much longer between grindings than if the blades were made from the tempering steels. At the present time when high-speed steel can be obtained in all the ordinary sizes and shapes in an annealed state, it is advisable to make not only the blades of *inserted bladed* mills, but also roughing hollow mills, which are made in solid form, of this high-speed steel. Its first apparently high cost is more than offset by the amount saved by its use.

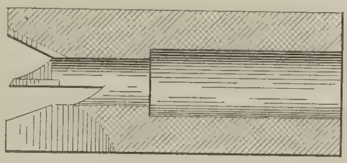

Fig.3

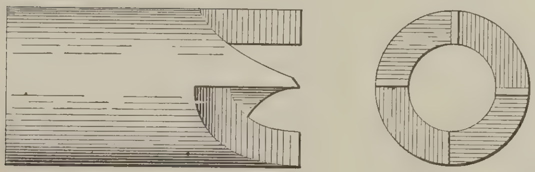

Fig.9

Hollow mills must be given clearance, so that they may not bind when in use. This is accomplished by several methods. One of the more common methods consists in making the hole tapering, having it smallest at the cutting end. Fig. 1 shows a hollow mill whose hole is enough larger at the portion marked *b* than at *a* to prevent "hugging" of the work, thus roughing it or twisting it off.

In the case of small mills, the hole is tapered by means of a taper reamer; those having larger holes may be given taper by boring in the lathe or by grinding with an internal grinder after the tool is hardened. For many purposes it is considered advisable to make the hole straight, and give the necessary relief by working off the lands, as shown at *a*, Fig. 2. The relief is carried to face *b*, but none of the stock at this point should be removed. If the hole in the mill is sufficiently large the greater portion of this stock may be removed by means of an end mill, and the work finished by filing, but if the hole is not large enough to allow of this, the stock is removed by filing. When the hole is made tapering, as described under the first method, and the taper is produced by reaming or boring, this must be done before cutting the teeth. If relief is given as shown in Fig. 2, it is, of course, necessary to form the teeth before giving relief.

Roughing Hollow Mills.—Roughing mills are used for removing the bulk of the stock, leaving a sufficient amount for the finish mill or box tool. In order that they may start on the stock easily, this form of mill is often made as in Fig. 3. Roughing mills are usually made solid, that is, with no means of adjustment. The teeth are made stronger than those on finish mills, which are generally made adjustable.

Adjustable Mills.—This form of mill has its teeth cut deeper than a solid mill; that is, they are longer and slenderer, to allow them to spring for the desired adjustment. The adjustment is obtained by means of a clamp collar of the form shown in Fig. 4; or a collar may be used having a setscrew to adjust each jaw, as in Fig. 5. Some mechanics consider it best practice to get the desired adjustment by means of a collar having a tapered hole which fits on a tapered portion at the end of the mill, as shown in Fig. 6. When it is necessary to close the mill, the collar is driven further onto the tapered portion. The advantage claimed for this form of adjusting collar is that the teeth are all closed uniformly, thus insuring a uniform cut on all the teeth.

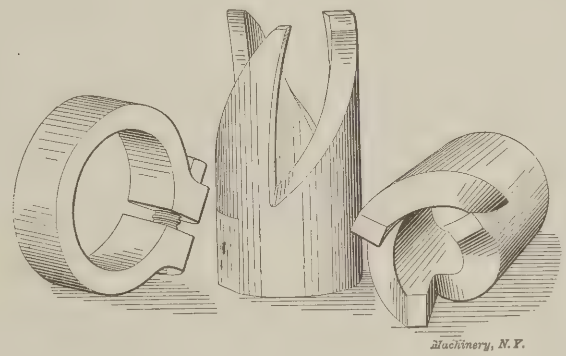
Machinery, N.Y.

Fig 4.

When the mill is too small to allow of grinding the hole to size after it is hardened, it must be given the desired clearance with a taper reamer, reaming from the back end so that the hole may be smallest at the cutting end. The amount of taper should not be great; a small amount provides sufficient clearance to prevent binding and permits of more grinding before the mill is too large to allow of the adjustment necessary to bring it to the desired size. The Stubbs broaches formerly used so extensively in machine shop work seemed to provide about the proper clearance.

As previously stated, when cutting the teeth of adjustable mills, they must be cut deeper, longer and slenderer than for solid mills, so that they may be sprung together to provide means of adjustment for size. They should not, however, be so slender as to chatter when in use, and should be strong enough at the base of the tooth to prevent the tooth springing in the direction of the pressure applied when cutting. The form of tooth provided this class of tool varies in different shops. In some the tooth is of the form shown in Fig. 7, while in others it is thought best to make it as in Fig. 8, provision for adjustment being made by means of saw cuts as shown.

When roughing mills are to be used in screw machines for roughing down square or other forms of irregular stock, as well as round stock, it is well to bevel the teeth at the cutting end in the form of a V, as shown in Fig. 3, so that the tool may center itself when starting to cut. If the shoulder at the end of the cut must be square it is necessary to follow the cut made with this mill by the tool whose end is of the form shown in Fig. 9.

Roughing mills do not require as many teeth as those used for finishing; the fewer, the better, provided there are enough to properly support the work, as this leaves more room for chips, and chips are the most troublesome thing the mechanic has to contend with in the ordinary processes of machining with tools whose cutting edges are formed of a number of teeth. The teeth of roughing mills should be short and stubbed, to provide strength. Ordinarily they are four in number, although for certain work three has been found preferable; and for some classes of work mills having but one tooth have been found to work nicely when those having more could not be made to work at all. Such mills, however, seldom work well except when run through a bushing, which, of course, guides and supports it when working.

The writer was connected for a number of years with a company who manufactured calipers, dividers and other machinists' tools. We had occasion to cut a circular groove at opposite sides of the caliper nut, and a ring was put in each of these grooves after the nut was sawed in two, thus making a quick-adjusting nut. The nut was placed in the jig and the groove cut with a hollow mill. We found that a mill with two or three teeth would not work, as the chips soon clogged the mill and caused it to break when pressure was applied to make it cut. When given only one tooth the mill worked nicely.

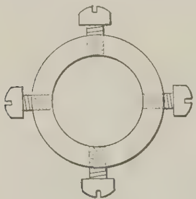
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Fig. 5.

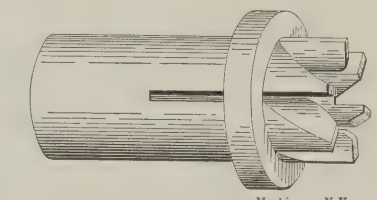

Machinery, N.Y.

Fig. 6.

When roughing mills are used on round stock three teeth work very well; if square stock is being cut a mill having four teeth will work more satisfactorily, as the opposite corners will be supported at the same time.

Hollow Mills With Pilots.—It is oftentimes desired to machine a projection true with a hole, as indicated in Fig. 10. This may be accomplished by using a mill having a pilot, as shown. As mills of this character are rarely used on small work it is generally feasible to grind the walls of the hole to size, and with the necessary clearance, after they are hardened. When possible make the hole to receive the pilot large enough so it may be ground at the same time, to insure concentricity. Fig. 11 illustrates a mill having a hole of this character, the pilot being made with two sizes to accomplish the desired result.

Unless quite a number of tools of a kind are made in a shop it is not thought advisable to make special fixtures and holders for doing the work. As a consequence the operator is called upon to improvise something that will accomplish the desired result, and yet do away with the cost of the special tools required when work is done in quantities. The man who can devise ways and methods of producing accurate work, where the necessary machines and tools are not available, and can do it satisfactorily, without materially increasing the cost, is the valuable man. Now we all know that the only means provided for holding work of the character under consideration in the ordinary universal grinder is a three or four-jawed chuck. If the chuck is universal jawed it is in all probability not true; and if it is an independent-jawed chuck it is almost impossible to true the piece of work to run as we wish it to. While this may be accomplished very nicely on the lathe, where we can detect any error by means of an indicator, the circumstances are so entirely different with the grinder that it becomes a very difficult task. However, we may get the work to run true by holding the back end in a collar held in the chuck. This collar should have a hole a few thousandths of an inch smaller than the end of the piece we wish to grind. After securing the collar in the chuck, the hole may be ground to a size that allows of wringing the work into it sufficiently tight to hold it while grinding. If the piece of work be long the outer end may be supported in the *back* or *center* rest.

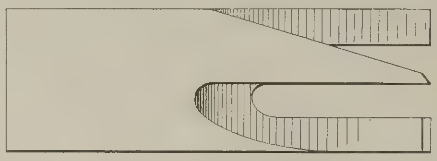


Fig 7

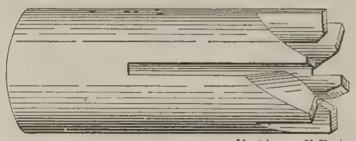


Fig.8 Machinery, N.Y.

Hollow Mill in Place of Counterbore.—Very often it is necessary to enlarge a hole to a degree that makes it a costly operation when a counterbore is used. A hollow mill having a pilot will be found to furnish an easier and a cheaper method of accomplishing this. It is, however, open to the objection that the portion removed has a decided tendency to stick in the mill, thus causing a great deal of trouble. This is overcome by making the interior portion eccentric to the outside; in other words, by having the wall thicker at one side than at the other. The pilot must, of course, be concentric with the *outside.*

If the mill is to be guided by a bushing no pilot is needed. Fig. 12 shows a hollow mill designed for use as described above, while Fig. 13 shows a piece of work for which such a tool is specially adapted.

When the hole to receive the pilot has been made and the body and pilot have been turned and finished to size the large hole in Fig. 12 is bored to desired size. This is accomplished by placing the mill in an independent jaw chuck, moving the jaws until the mill is located to give the desired amount of eccentricity, which for a mill of 1½-inch diameter may be 1-100 to 1-64 inch. This amount may be varied for different sizes of mills.

If the stock to be cut is thick the mill should have fewer teeth than when it is used on thin stock. The exact number cannot be stated arbitrarily, but must be governed by conditions under which it is to be used. If possible, the teeth should have space enough between them to hold the chips removed; otherwise it will be necessary to withdraw the tool from the cut and remove the chips to prevent the teeth from breaking. A common fault with certain classes of cutting tools is teeth that are too fine, or in other words insufficient space between teeth.

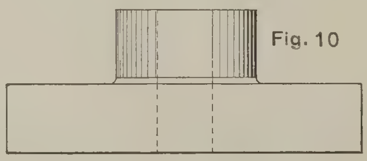


Fig. 10

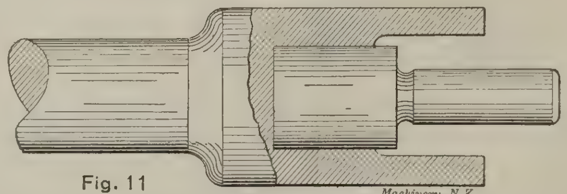


Fig. 11 Machinery, N.Y.

Hollow Mills With Inserted Blades.—This form of hollow mill is of especial value when the tool is large, or when it is to be used on hard stock or on material covered with a hard scale. The blades being removable are easily sharpened when dull, or can be replaced at slight expense when worn out, thus saving the expense of a new tool. Then again the blades may be made of high-speed steel, as stated in the fore part of this article, which makes it possible to cut hard stock, or to run at a high rate of speed when machining.

As a rule high-speed steel, even when purchased in bars of the right size and shape, does not give as good results if used in the condition in which it is bought as when properly hardened before using. If it is found necessary to machine this steel to size, by means of cutting tools, it can be annealed to work very nicely by packing in a tube, or an annealing box, with a quantity of dry fireclay and subjecting to a full red or a yellow heat for a number of hours, then allowing it to cool very slowly, as described in a former article on "High Speed Steel."

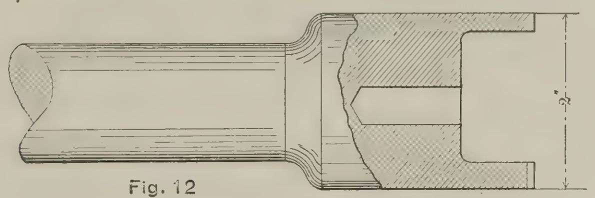


Fig. 12

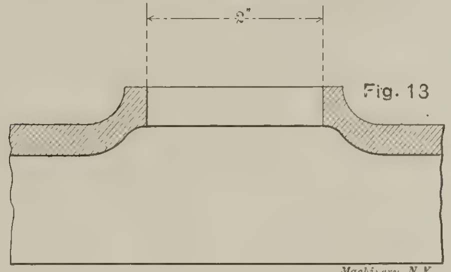
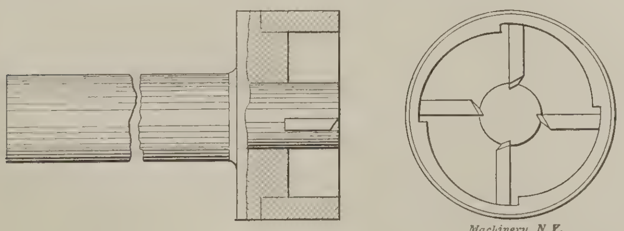


Fig. 13

Machinery, N.Y.

After annealing it may be machined with tools used for machining other kinds of steel, but best results follow the use of tools made from high-speed steel.

Most makes of this steel need a very high heat when hardened. The exact amount I have found to vary for different steels; most of them require what is familiarly termed a white heat, although one make that I have used with excellent results hardens at a red heat. However, as instructions are furnished with the steel there need be no experimenting as to the proper heat for the individual steel. When it has been given the proper heat it may be hardened in an air blast, or in oil, the latter being generally used for tools where size must be retained or where a poor surface would not be desirable. When heating for hardening it is generally necessary to use a method that will prevent scaling the surface. A good way is to heat in a crucible of melted lead, heated to the desired temperature. Heat the steel first in a fire, or in another kettle of lead which is not heated above a low red; for if the steel were plunged in lead which is heated to a white, while it is cold, it would expand so rapidly at the surface as to cause it to crack. It is therefore apparent that it must be heated gradually until it is plastic, when it is safe to plunge it into the lead at the high heat.



Machinery, N.Y.

Fig. 14.

A more satisfactory method of heating this kind of steel consists of a form of gas furnace especially designed for this class of work. In this furnace the steel can be given any amount of heat, and the surface will be free from scale, as it is removed from the action of the air while heating in the furnace, and consequently the surface cannot oxidize.

There are many styles of inserted blade hollow mills, a few of which we will consider. As in the case of all tools used in the machine shop, the design of a form of mill must be selected whose first cost is not out of proportion to the amount saved by its use. It is not always good policy to make a form of tool whose first cost is in excess of another, even if the cost of machining each piece would be materially reduced thereby. This is especially true where the number of pieces to be machined is small. In other words, it is not generally considered advisable to make the more costly form of tool unless the cost of the tool plus the cost of machining is no greater than the cost of the cheaper tool plus the cost of the work it does. Where great numbers of pieces of work are done and the same operations are repeated for an indefinite period a design of tool is generally adopted which will produce the work in a satisfactory manner at the least cost, with no special regard to the first cost of the tool. By this I do not intend to convey the idea that the cost of tools should not be considered; on the contrary, I believe a strict account should be kept of the cost of every tool and that the probable cost and the amount to be saved by its use should also be considered before deciding to make it.

A form of hollow mill made in some shops where mills with inserted blades are used is shown in Fig. 14. The blades being in slots, the outer ends of which bear against the inclines in the rings, can be readily adjusted to size. This form of mill is rather expensive and as a result is seldom made unless a tool of this character is to be used almost constantly. The operations of making are very similar to those for the self-opening die described in a previous article.

Another form of hollow mill having inserted blades is shown in Figs. 15 and 16. Fig. 15 is a roughing mill and a form used for finishing surfaces. This mill can be made more cheaply than the form shown in Fig. 14, but is open to the objection that it cannot be set to size and alignment so easily.

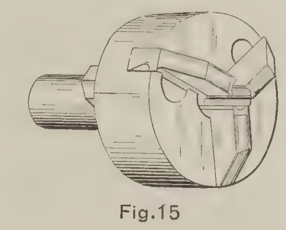


Fig.15

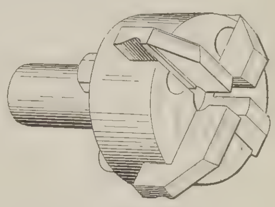


Fig.16

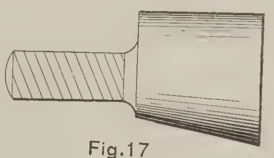


Fig.17

Machinery, N.Y.

Blades for machining various sizes of work may be made for this mill, so that it can be used for quite a range of sizes of work. As stated in the case of the mill previously described, high-speed steel may be used for the blades, thus making it possible to run at high rates of speed.

The holder is made from machinery steel, the shank fitting the holes in the turret of the machine in which it is to be used. The slots for the blades are cut to the proper width and depth, and with the edge corresponding to the cutting edge of blade, radial—on line of center.

The blade has a bevel cut on one side. A stud having a corresponding bevel on one side, as shown in Fig. 17, is used as a binder, and binding is accomplished by drawing the binding stud down on to the bevel of blade by means of a nut on the back of the body—or head—as shown. The roughing mill is ordinarily given three cutting edges as represented in the cut. The finishing mill differs from the roughing mill in that it has two blades and two back rests, the latter steadying the work while the blades are cutting.

When a hollow mill is wanted which can be made more cheaply, the design shown in Fig. 18 may answer the purpose, although it cannot be set as accurately as the form shown in Fig. 14, especially as to alignment.

This style of mill is used on large work. The slots should be milled with a cutter whose thickness corresponds with the corresponding dimension of the steel to be used for the blades. If the stock to be milled is hard or in any way difficult to machine, or if it is desired to machine it at a high speed, use high-speed steel in the construction of the blades. The slots to receive the blades should be cut somewhat deeper at the front end in order to provide clearance; this also allows of a slight adjustment in size, as the blades if moved ahead in the slots will cut a trifle smaller. Two collars of machinery steel should be provided, to hold the blades in place. The holes in these collars must be of a size that allows them to readily slip over the blades when in position in the slots. Each collar must be provided with the same number of setscrews as there are blades in the hollow mill, as there must be a setscrew bearing on the blade at each end. The collar placed nearest the shank of the mill holds the blades securely in the body; the other is placed near the cutting edges, as shown, to support them while cutting. The length of surface cut with a mill of this character is somewhat limited; the cut can be no longer than the distance the blades project beyond the holder.

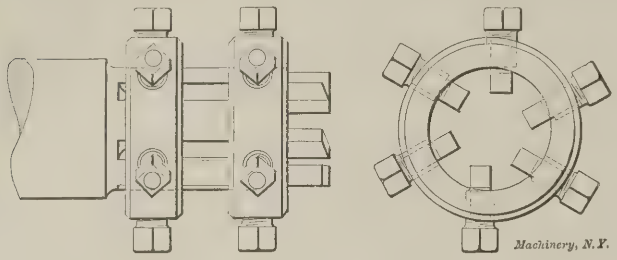

Machinery, N.Y.

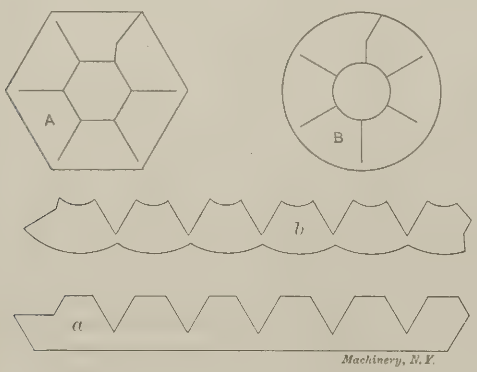
Fig. 18.

As stated, this mill can be adjusted by moving the blades back and forth in the slots. The amount of adjustment can be still further increased by placing thin strips of metal, or even paper, in the bottoms of the slots beneath the blades. When milling the slots for the blades it must be borne in mind that the edge of the slot corresponding to the cutting edge of the blade must be radial.

* * *

HOLLOW BLOOM TUBE-MAKING IN ENGLAND.

The process of hollow bloom tube-making, the invention of Mr. George Inshaw, is described in a recent consular report by Consul Halstead at Birmingham, England. The inventor's object is to produce a seamless iron or steel tube for steam, gas, or water, and all other services, and other hollow articles such as shafting, all to be of a better quality and produced at less cost than when made from strip; of a better quality than when spun over a mandrel; equal to any tubes made from a pierced or bored bloom; and perhaps, owing to the amount of work the metal received in the rolling, of as good a quality as when cold drawn.



Machinery, N.Y.

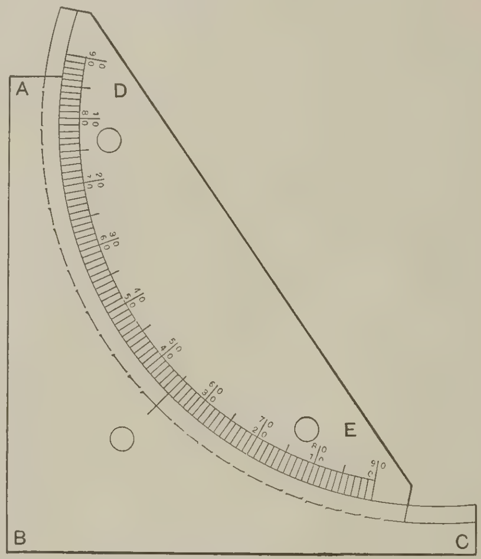
Hollow Bloom Making.

Puddled iron balls are first formed into slabs by means of a steam hammer, and these slabs are then rolled into blocks or bars, with longitudinal segmental projections connected with a thin backing or plate of metal, a cross section of which is shown in the accompanying cut, as are cross sections of the two kinds of hollow blooms, which may be formed by the rolling of either of the two forms of segmental projections on the bars. In one kind the interior of the bloom is round, as also is the exterior; in the other the interior is hexagonal and the outside approximately the same shape. The plates or bars, without reheating, are rolled or formed by being passed through a skelping machine, which bends the thin backing or belt of metal, bringing the longitudinal segmental projections together, thus forming long hollow blooms. These long hollow blooms are sawed into required lengths, and, while still retaining much heat which is not exhausted in the first process—the interior of such a roll naturally retaining heat—are put into a furnace and the heat is raised to a welding point; then they are passed through welding rolls, and, without further heating, made into tubes. The advantage in welded rolled blooms over built-up hollow blooms, would seem to be in the fact that there is less surface for oxidation, and, contrary to the prediction of experts regarding the Inshaw bloom, the angles of the rolls when pressed together seem to push out any oxidized particles into the hollow of the bloom when the inside hexagonal type is used. The rolled bars and corresponding shaped blooms are indicated at *A a* and *B b* respectively.

* * *

ADJUSTABLE PROTRACTOR TRIANGLE.

The cut shows what should be a handy instrument for the draftsman, being a white celluloid triangle having the angles of one side adjustable. The instrument consists of the right-angled part *ABC* and the segmental part *DE*. The circular edge of *DE* is formed with a tongue which fits into a corresponding groove in *ABC*. The edge of *DE* is graduated into degrees so that the outer side may be set to any angle from 0 to 90 degrees with the base. The diameter of the protractor circle is 7 inches and the sides *AB* and *BC* are each about 4¼ inches long. The segmental part slides easily within the other, but the friction is ample to prevent sliding when the pressure of the pen or pencil is applied to the drawing edge. The protractor triangle is the design of Prof. D. A. Low, and is being placed on the market by Longmans, Green & Co.



Industrial Press, N.Y.

Adjustable Protractor Triangle

* * *

An objectionable feature of many dynamos is the humming noise that accompanies their operation. This trouble is found to a considerable extent only with machines having laminated poles and a small number of slots per pole, say, six to nine, and it generally increases as the air-gap between the armature and the poles is narrowed. A German investigator has determined by the use of tuning-forks of known frequencies that the number of vibrations in a second, denoting the pitch, agree in every case with the number of armature teeth passing a given point in a second. It may, therefore, be inferred that the sound is produced by the variations of magnetic flux in the teeth. The investigator has deduced a formula for the relative proportions of pole shoes, width of air-gap, number of slots, etc., which, if followed, has been found to decrease the humming to a minimum or to stop it entirely.

THE MAKING OF SOUVENIR SPOONS.

ALEUS.

How many people as they stop and gaze in a jeweler's display windows and see trays of souvenir spoons with the name of the city or town, or the outline of some prominent building stamped in the bowl or the handle, ever stop to think of the number of operations and the amount of labor required to complete one of these spoons for market?

The majority of these spoons are made of sterling silver, which is purchased from an assayer in an ingot at a certain price per pennyweight. The silver is melted in crucibles and the furnaces are usually gas burning, as the heat has to be great. As the silver melts, a small handful of charcoal is sprinkled over the silver in the crucible; this clears all sediment and draws it all to the surface. When the silver is melted, it is poured into a mold which varies in size, the most common being 3 inches wide, ¾ inch thick and 12 inches long. This mold is polished and free from all blowholes and small pits that usually appear in cast iron, of which this mold is made. The mold is always made on a slight taper with a false piece of steel fitted at the bottom; this is used in loosening the ingot by driving on the wedge or false piece. The mold is usually heated and swabbed with a piece of oily waste to prevent the metal from adhering. After the silver has cooled in the mold to a certain degree, it is removed and, if found to be free from pits and air-holes, it is scrubbed with hot water, soap and a stiff brush to remove all substance adhering to the ingot.

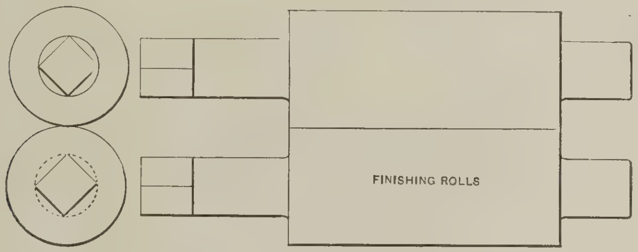


Fig. 1

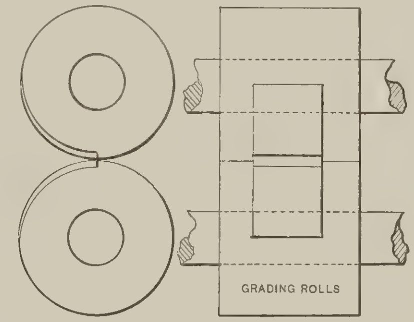


Fig. 2

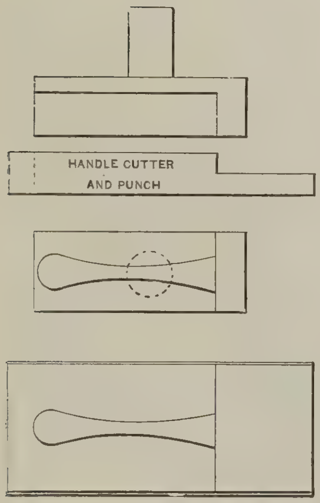


Fig. 3

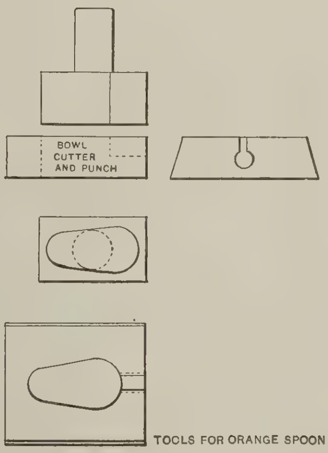


Fig. 4

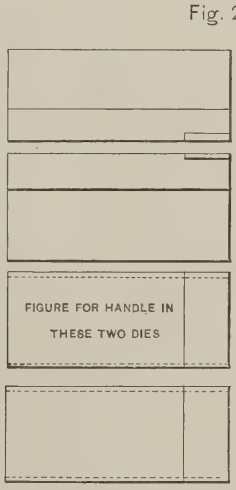


Fig. 5

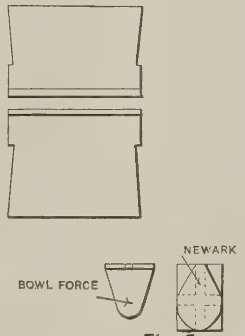


Fig. 7

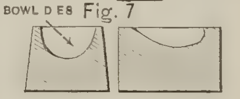


Fig. 6

Machinery, N.Y.

Tools used in Making Spoons, with Special Reference to Souvenir Spoons.

The next operation consists of breaking down, which is taking the ingot of silver after it has been scrubbed and rolling it through rolls made of tool-steel, hardened, ground and polished. These are usually 6 inches diameter with a 10-inch face, the size being generally determined by the size of the ingot to be rolled. The silver passing and repassing through these rolls becomes thinner and greater in width at each consecutive rolling, and the rollings are continued until the silver begins to crack on the edges. The operator then knows that the metal has become so brittle that it must be annealed before any more rolling can be done. The ingot of silver is now about ⅜ inch thick, 5 inches wide and 20 inches long. The operation of annealing consists of grasping one end of the silver with tongs and passing it back and forth through a gas furnace until it is red-hot; it is then allowed to cool. After cooling, it is placed in an acid bath, which removes all the oxide and discoloring caused by heating. After the acid bath it is plunged in another bath of boiling water and scrubbed to remove all traces of the acid to protect the rolls from being disfigured by same. The silver is dried by covering with hot sawdust and is then put through the same operation of rolling again, the annealing process taking place as often as the silver requires it, which is determined by the silver cracking on the edges as mentioned before.

Great care must be taken during the operation of rolling to have the rolls exactly parallel with each other; if the rolls are not parallel the stock will curl and not roll straight, thereby stretching the silver more at one side than at the opposite, which causes it to break. Fig. 1 shows the shape of the rolls used. These rolls have to be ground and polished from time to time as they wear irregular and, therefore, do not roll the silver perfect. Again at times an imperfection appears on the surface of the rolls which must be removed as it will always show on the silver.

After the silver has been rolled to its desired thickness, it is then annealed for the last time, pickled and dried, then taken to the finishing rolls, which are made the same as the breaking down rolls, but smaller in diameter and ground more accurately and polished to a better finish. These rolls do no heavy rolling, but are used simply as sizers to bring the silver uniform in thickness. After passing through the finishing rolls, the silver, which is now in a rolled sheet varying in thickness from 0.025 to 0.035 inch, is taken to a pair of rotary slitting shears where the rough edges are trimmed and the roll of silver stripped into desired widths. The rolls of silver, together with the scrap that comes from the shears and that which remains in the crucible after melting (called the "button") are taken to the office and weighed to determine the shrinkage and waste. The silver is now ready to make into spoons.

The silver being in rolls it is taken to the shears and cut into pieces the desired length which vary according to the size of the spoon. The next operation consists of what is termed "grading," which is tapering the ends of the pieces of the silver for the handle and bowl. The pieces of silver are always cut shorter than the spoon itself as the "grading" operation lengthens the piece. The operation of grading is accomplished by the rolls shown in Fig. 2. These rolls are cut away in the center about ⅛ inch deep at one side and gradually lessening until the cut rises to the face of the roll. This section of the roll is usually about 2 or 3 inches wide, the length being about one-quarter the circumference of the roll. The rolls always run in the direction of the taper, or, in other words, the rolls revolve, so that at one given point the deepest portions of the recesses meet, having at this point a combined depth in the two rolls of ¼ inch. It is at this point that the spoon is inserted for grading. As the handle and bowl are differently graded, there are two of these recesses in each roll. The pieces of silver are taken between pliers, the jaws of these being of a length to determine the length to which the silver is to be placed in the rolls. When the rolls have come to the point where the recess space is greatest, the operator is ready with the blank adjusted in the pliers. He pushes the projecting portion of the blank in the opening until the pliers come in contact with the rolls. In this position he holds the blank until the rolls grasp it and reduce the taper. The rolls are mounted in housings and are adjustable to any thickness.

Having graded both ends of the blank, it is then blanked out in a die made as shown in Fig. 3, which cuts the form or outline of the handle, leaving the bowl end in the state it left the grading rolls. I will explain the object of performing this operation in this manner. Generally a shop manufacturing spoons of this nature has various designs of handles, also it has a line of bowl dies of various sizes and designs. A mixed order is received in which so many spoons of the order are to have a certain handle and bowl, and a certain number to have another design of handle and bowl. By making the dies as shown, any style of handle can be made on any bowl or fancy spoon. Having blanked the handle, another die, Fig. 4, is used to blank the bowl. The blanks are now ready to have the design stamped on the handles.

This work is done in a drop-hammer between the dies shown in Fig. 5. In the dies is cut the design that is required on the top and bottom of the handle. These dies are called matched dies. The depth of the design always determines the thickness of the silver to be used—the greater depth, the thicker the stock. The blanks then pass through the operation of trimming which consists of being forced through dies similar to Figs. 3 and 4, but instead of the punch being flat, the center is cut away leaving a knife-edge on the outside. This is done to relieve the punch, so it will not disfigure the design, and at the same time allow it to cut a clean edge. Having trimmed the handle and bowl, the next operation consists of bowling, or, in other words, to bend the bowl from the flat to the desired shape.

This work is also done in a drop-hammer with the dies, Fig. 6, and the force, Fig. 7. The die is placed between the poppet on the drop-hammer bed and the force is secured in the jack-die, which is fastened to the hammer. The operator now places a blank on the face of the die, releases the hammer, which descends and the force presses the spoon bowl into the die. An automatic drop-hammer is the best for this operation, as it strikes every blow with the same force. If the name of any city or town or the outline of any particular object is desired in the bowl of the spoon, it is cut in the force as shown in Fig. 7. Doing this brings two operations into one, for, as the bowl is formed, the design appears.

The spoons are now passed on to the bench, where the filing is done. This operation consists of filing off the burrs and ragged edges on the bowl. The spoons then go back to the press department, where the handles are curved by being pressed between two hardwood blocks formed to the shape desired on the handle. The spoons then pass into the polishing room to be "boled"; this work is done on an ordinary polishing head, using a cloth wheel with a coating of rotten-stone, which has to be renewed at intervals. The boling removes all sharp edges and scratches on the silver, after which the spoons are polished by using another cloth wheel coated with crocus.

The spoons are then sent to the coloring room for the next operation, which consists of plating the bowls with gold in an electro-plating bath. Some bowls are oxidized; others pass through the operation of sand-blasting, which gives the spoon a dull finish. The spoons that are gold-plated are sent back to the polishing room and again polished, after which they are washed in a solution of hot water and ammonia to remove all stains, and finally they are dried in hot sawdust, when they are ready for the shipping room.

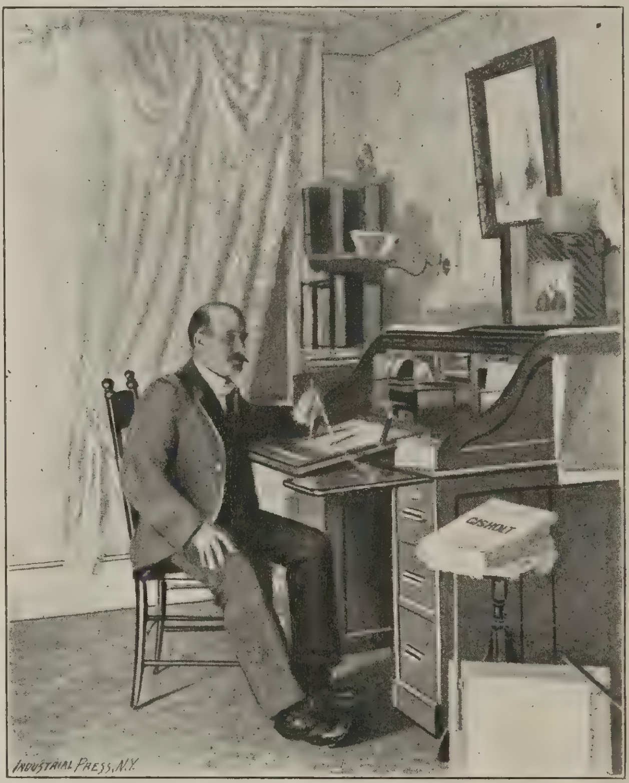
The souvenir spoon industry is very large, one firm alone having over 1,000 designs for bowls, which include the names of every city in United States and Canada of any size, and a large number of cities in other countries.

* * *

A MACHINIST'S DEN.

We presume that many of our machinist friends, who believe in the principle of "self-help," have their own ideas and ambitions for a study and drawing room at home, and that, consequently, they will naturally be interested in what some one else has done. For this reason we reproduce the photograph of the den of Mr. C. W. Putnam, Holyoke, Mass., one of our frequent contributors. The principle article of furniture is the roll-top desk. The desk is conveniently arranged so that it may be used as the support for a drawing-board, or can be quickly cleared away for writing. In his letter describing the den, Mr. Putnam says:

"When I use the desk for drawing, my board is resting on the two slides at the sides as shown, and is tilted in about the right angle for convenience; my drawing tools are kept on the right-hand slide. In the foreground you will notice a perspective drawing board I designed, showing a corner of a carpenter shop with work bench. [This cannot be distinguished in the cut.] This bench was drawn by the use of the pins located near the end of the rods, using a rule to guide the pencil; these pins represent the vanishing points, and their location can be arranged on or off the board as desired, as the rods are held to the board by a swivel clamp.


INDUSTRIAL PRESS, N.Y.

Mr. C. W. Putnam in his "Den"

"On the desk will be noticed a card index that I use as a catalogue in connection with my letter files, books, mechanical papers, etc. By referring to this card index I can locate in a minute any letter in the files, or any drawing or manuscript that has been prepared. These I keep in the filing cases on top of desk and in the drawers; also on file clip at the right hanging on a hook. At the left in the corner I keep my mechanical books which are also catalogued.

"For the benefit of non-contributors, I will state that all this shown in the picture was purchased with money obtained in return for my articles published in MACHINERY and other mechanical papers."

LETTERS UPON PRACTICAL SUBJECTS.

A MANUFACTURER'S VIEW OF MAKING SMALL COIL SPRINGS.

Editor MACHINERY:

I read with interest the article in the June number of MACHINERY entitled "An Experience in Making Coil Springs." My interest would have been even greater if the time used in making the 60,000 springs and the cost of the tools for producing them had been stated.

The trouble Mr. Beverts had in making these springs is nothing unusual, and his methods of solving the difficulties he met with are very ingenious, but it only emphasizes again the old adage, "every man to his trade." I venture to say that any good spring maker could have produced these springs cheaper and Mr. Beverts would have escaped all the annoyance and toolmaking and would also have had better springs.

In these days of specialization it is unwise for any one without the proper modern equipment to attempt to make springs, or indeed any small parts that can be bought of specialists in that line. Any modern spring maker is equipped to make the spring in question, with ends drawn in and flattened to give a good bearing surface, at almost no extra expense for tools. The cost of the special tools made in this case would have represented a good profit to the manufacturer on the job.

F. E. WHITTLESEY.

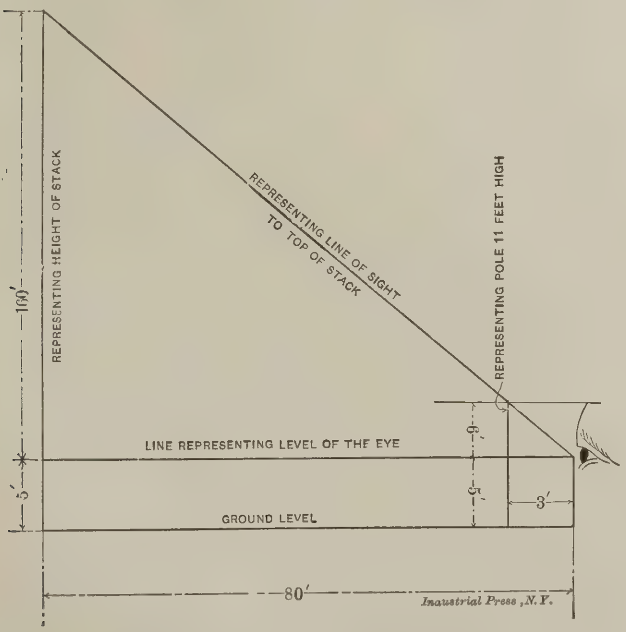
Corry, Pa.

FINDING THE HEIGHT OF A SMOKESTACK.

Editor MACHINERY:

Referring to the article "Finding the Height of a Smokestack from its Shadow," in the June issue, this suggested the query, "What if there was no shadow on the day the Chief Draftsman was ordered to get the height of stack?"

The proper thing to do then would be to take a pole about 11 feet long, and with an assistant to hold it in position while the "Chief Draftsman" would sight over the top of the pole to the top of the stack, either by sighting from the ground or by standing erect, the triangle between the pole and the level of his eye can easily be determined. Knowing the height to his eye from the ground, and the distance from his eye to the pole, it becomes a very simple problem in mathematics; in short, if the "Chief Draftsman's" eye was 5 feet from the ground, and the 11-foot pole was 3 feet from him, the triangle formed would show a 6-foot side above the level of his eye. Hence, if a man located 3 feet from and sighting over an 11 foot pole (with eyes 5 feet from the ground) projects the side of a triangle 6 feet high, a man whose eye was on the ground would project a side 22 feet high, and as the "Chief Draftsman" stands 80 feet from the stack, which is equivalent to a base of a triangle, it would require a pole or stack 160 feet high (plus 5 feet) to project a base 80 feet long as the same proportion.


REPRESENTING HEIGHT OF STACK
160'
REPRESENTING LINE OF SIGHT TO TOP OF STACK
REPRESENTING POLE 11 FEET HIGH
LINE REPRESENTING LEVEL OF THE EYE
6'
5'
5'
3'
GROUND LEVEL
80'

Industrial Press, N.Y.

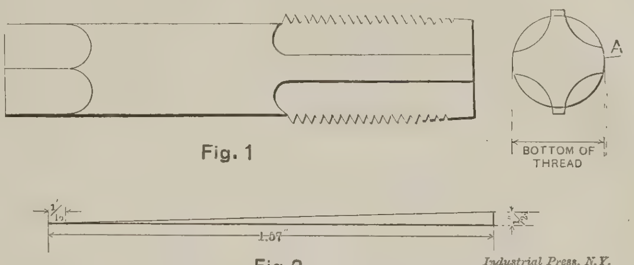
Finding the Height of a Smokestack.

Williamsport, Pa. A. P. SHARP.

TAPPING A LEFT-HAND NUT WITH A RIGHT-HAND TAP.

Editor MACHINERY:

I noticed in the November, 1903, issue of MACHINERY a method of cutting a left-hand screw thread by using a right-hand tap in holder, and have been waiting for somebody who had more time than myself to suggest the solution to the question there propounded of tapping out a left-hand nut with a right-hand tap.



Industrial Press, N.Y.

Right-hand Tap Ground for Tapping Left-hand Nuts.

Some years ago while foreman of a good-sized machine shop, a job came up where it was necessary to cut right and left threads in opposite ends of a cylindrical drum. At the time we had just increased the drafting force by engaging an assistant who was to brace up especially the designing end of the business. This young man, being asked some questions in regard to the right and left taps that were to be made for the above-mentioned job, said "Why, what is the use of making a left-hand tap? Why don't you turn the tap right around on the other end and tap the left-hand threads?" There was something a little broader than a smile went over the faces of the hearers at this proposition, and to let the young man out of his delicate position one of the men, who had learned his trade at a gunsmith's, said he had tapped out many a left-hand nut with a right-hand tap and to prove his statement produced a very good looking left-hand nut which he said was finished with a right-hand tap. This set the boys thinking and one of them finally produced a very good left-hand threaded hole by using a right-hand tap.

I think the tap used was a special size ½ inch diameter by 24 pitch, right-hand with four flutes. Two opposite lands were ground down to the bottom diameter of thread as shown in Fig. 1 at *A* to support the tap while cutting through the hole. The other two lands were ground down on the sides of the teeth leaving the lands about 1-16 inch wide, as the narrower the lands are made the less resistance will the tool make during the cut.

The piece that was experimented upon was a plate strapped to the cross-slide of an elevating tool-post rest and the tap made as shown in Fig. 1 was held rigidly in a drill chuck in the live spindle. The hole in plate was then lined up opposite tap and the lathe set up to cut the same pitch thread as that of the tap. The lathe spindle was now revolved backward with forward carriage feed and the tap run through hole.

The distance that the thread groove would be crowded over making it larger than if a regular left-hand tap were used is less in actual practice than the figures call for, owing probably to spring both of stock to be cut and also of the teeth of tap. The amount which would be given by the actual figures of the lead on the ½ inch by 24 pitch would be by similar triangles (See Fig. 2), as follows: $\frac{1}{2} \times \pi = 1.57$, and by proportion $1\,57 : \frac{1}{24} = \frac{1}{16} : x = \frac{0.0026}{1\,57} =$ 0.0016 +, which, multiplied by 2, gives the difference between the lead for right and left-hand threads as 0.0032 inch.

HEXAMETER.

There is a more important reason for grinding away the teeth on two opposite sides of a four-fluted tap than that given by the correspondent. When the thread is changed from right to left the paths of the threads cross each other once in each half revolution so that the teeth of a right- and left-hand tap coincide as to position when on opposite sides. This being the case it follows that the lines of teeth 90 degrees in either direction will be found in paths midway between the paths of those teeth considered above and would cut a thread midway between that cut by the first. If anything was produced it would be a double thread of the same pitch, but the probability is that in as fine a pitch as 24 the threads would strip away owing to the pressure of the wrongly inclined sides of the teeth in the tap. Fig. 3 shows an enlarged developed surface and illustrates the matter quite clearly, *A A* being path of teeth in a right-hand and *B B* the corresponding path in a left-hand tap. J. A. W.

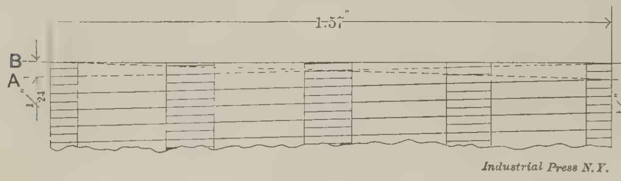


Fig. 3.

TOOLS AND JIGS FOR MACHINING AUTOMOBILE SIDE BEARING.

Editor MACHINERY:

I send you a blueprint of an automobile side bearing and sketches of tools and jigs for machining same. The side bearing is a steel casting, and the tools were designed to handle an exceptionally bad lot of castings, no two being alike. It was finally decided that the 41-64 inch and 49-64 inch holes should be drilled in the center of their respective lugs and all the subsequent measurements should be taken from these holes. The problem then resolved itself into designing a test jig which should show whether the castings would finish to the required dimensions.

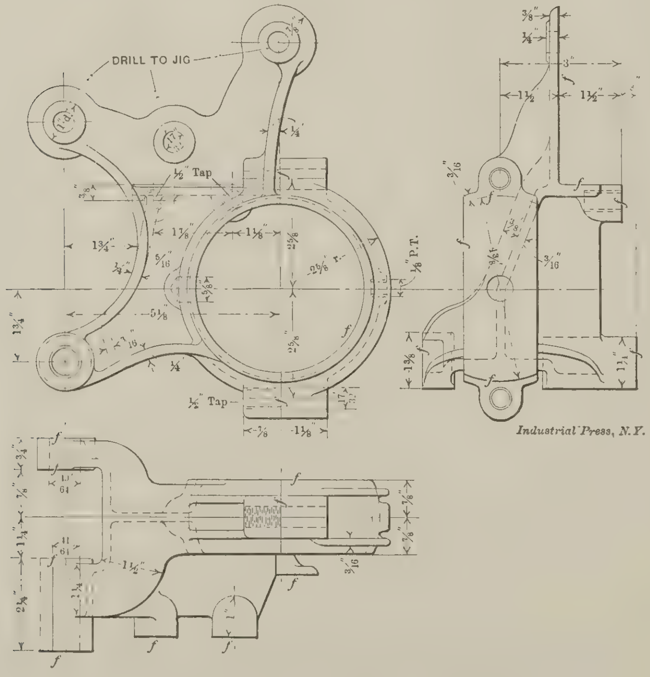


Fig. 1. Automobile Side Bearing to be Machined.

Fig. 2 shows the testing and planing jig with the work in position. *A* is a cast-iron plate to which is fastened a bell-shaped bushing *B* and two studs *C*. On the studs is mounted a cast-iron plate *D*, which in turn is threaded to receive another bell-shaped screw bushing *E*. The work is placed in position with the 1⅜-inch lug in the bushing *B* and the bushing *E* is screwed down on the 1¼-inch lug, bringing the two lugs in line. *F*, shown in the upper view, is the locating gage; it is a cast-iron block free to slide between pins. By pushing it up against the bearing the socket part of the casting is brought in certain relative position with the lugs. The jacks *G* are then screwed up against the casting and the whole thing is held down by clamp *H*.

The operation in this jig is the planing of the surfaces marked *f*. *I* is the gage for setting the tools for planing the 2 7-16-inch distance from the center of the socket; the gage is mounted on one of the studs, *C*, and is made 1-32 inch short of the required measurements, a 1-32 inch thick metal strip being used between it and the shaper tools. The stud is spotted for the setscrew to allow the gage to swing out of the way while planing and to be brought to the same position for the next setting of the tools. *J* is the gage for getting the 1½-inch and the 3-inch measurement from the horizontal center of the socket. The gage is free to move on the stud; the 1¾ inch part is set even with the sides of the socket and the shaper tool is set to the locating points of the gage. All the subsequent operations are performed from the surfaces planed in this jig. It will readily be seen that if the casting can be made to clean up it is safe to go ahead; the only exception is the cap stud holes, which had to be drilled to each cap separately. Of course while testing, it is necessary to clamp the work down, screwing down on the bushing being sufficient. The testing is done by placing a scale across the surface to be planed and moving the gage under it. The two setscrews, *K*, shown in the upper view, are to keep the work steady while being planed.

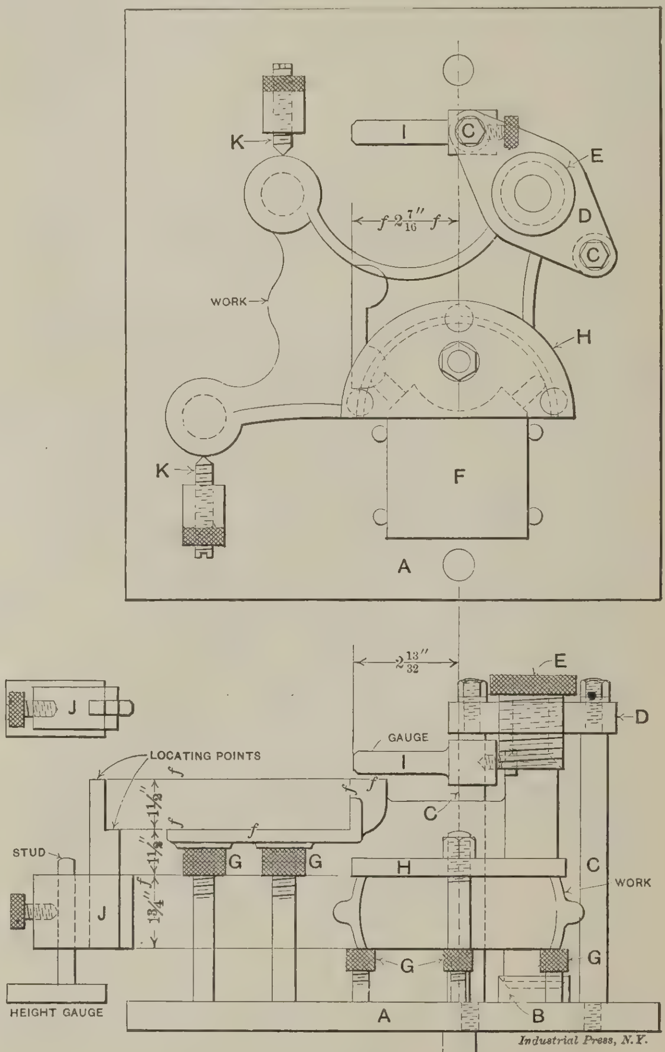


Fig. 2. Testing and Planing Jig.

The jig for drilling the three 17-32 holes, the two ½ inch tap holes, the 41-64 inch and 49-64 inch holes is of the simple box type, built up from cast-iron plates, and need not be shown. The jig for planing the joint surface for the cap is also a simple affair, consisting essentially of a cast-iron angle plate to which the casting is clamped in a vertical position, using a shaft through the 41-64 and 49-64 inch holes for locating same in conjunction with a stud fitting in the 17-64 inch hole. This jig is also used for drilling the cap stud holes.

The next operation is the boring of the socket, which is done with the cap in position. The tool used for that operation is, I think, worthy of some notice, and details are given in Fig. 3. *A* is a steel forging, *B* is a turret lathe holder revolving on a taper bearing; the surface marked *f*, in the end view, should be made a good scraped fit. A square 5-16 inch Novo steel cutter is inserted in the turret lathe and held down with a setscrew, as shown. The two operating stud nuts, *C* and *D*, are inserted in the holes drilled in the body of the tool and the tool-holder *C*. The turret nut is threaded to receive the screw *E*, and both are free to turn in their bearings. By turning the screw the tool-holder is made to revolve, and the tool being set the proper distance from the center (a suitable gage is provided for that purpose) the hole is bored the proper shape to fit a 4⅜ inch ball, provided the tool is set exactly central.

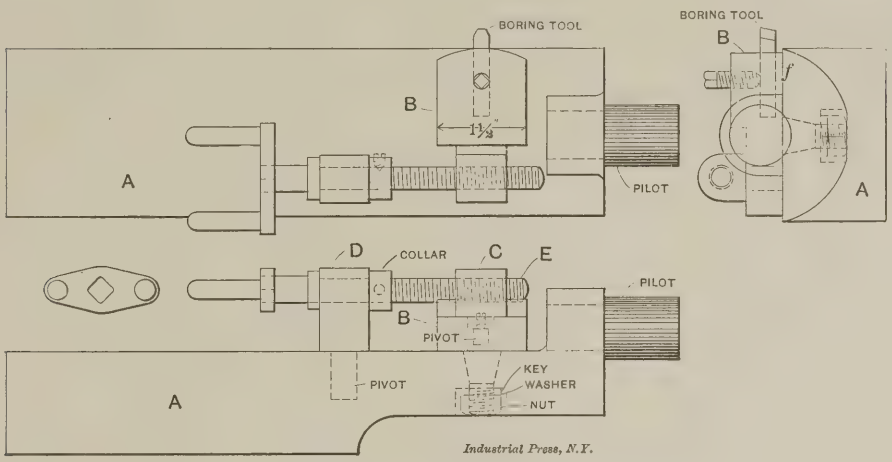


Fig. 3. Lathe Tool for Boring Spherical Socket.

How the tool is set central is shown in Fig. 4, which is the boring tool and jig for holding the work. *A* is a cast-iron plate fastened to a faceplate of a lathe. The work is located and held in the jig by the 17-32 inch hole, as shown at *B*. A hardened steel bushing forced into the jig acts as a bearing for the pilot. The tool is clamped to the carriage of the lathe so that the pilot will enter the bushing; bringing the shoulder of the pilot against the bushing brings the tool central and the proper distance from the planed surfaces and the previously drilled holes. L. MYERS.

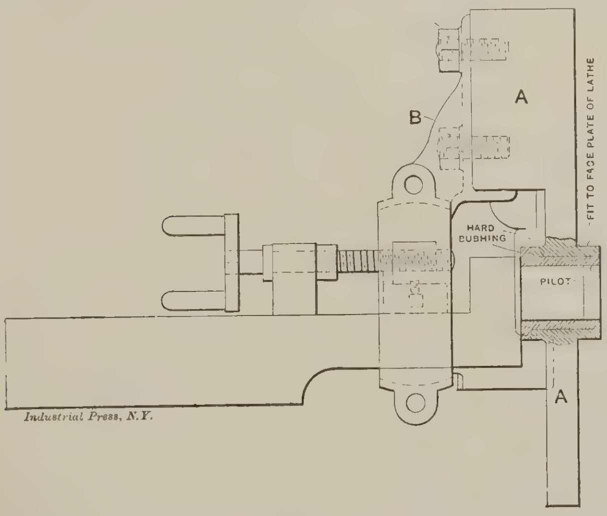


Fig. 4. Method of Holding Boring Tool Central.

Philadelphia, Pa.

HARDENING WORK IN PART.

Editor MACHINERY:

Referring to the letter from O. M. B. in the June issue on the subject of casehardening work in part, there is perhaps one shop in fifty that is equipped to turn out a job in this way, i. e., by applying a coating of copper by means of an electrolytic bath or otherwise. The carbonizing method is not at all bad, but by this means we are not sure of the desired result, and, furthermore, this process requires the services of a pretty good hardener. But any one can mix fireclay to the consistency of soft mud or dough and apply same to the piece to be hardened, on those parts that are wanted soft. The bare parts will, of course, be exposed to fire and water and will harden. If a large portion of clay is to be used on a piece and there is danger of same flaking or falling off, it may be secured by wrapping it with a sheet of asbestos and binding with wire. IRM J.

[The above, of course, applies to the hardening of steel already containing sufficient carbon to cause it to harden. It is also true that fireclay can be used in the casehardening pack, to prevent the bone coming in contact with the work where it is wanted soft. For that matter any non-carbonaceous matter that will stand the heat will answer equally as well. Sometimes the part to be left soft will be wrapped with a strip of sheet iron, or will be protected by a short piece of iron pipe.—EDITOR.]

ADVICE TO YOUNG MECHANICS.

Editor MACHINERY:

This is written for the perusal and thought of the young mechanic, employed in the small machine- and instrument-making shops, that is, those who have been employed upon one line of work and have become accustomed to the one method of working.

It would be more to his interest after spending three or four years in such a place, to secure another position, with a large firm employing the more modern methods and machinery for producing accurate and maximum amount of work. For he will find to his regret if, after being employed for twelve or fifteen years in the one place, he is compelled to secure another position with another firm, that it will be rather difficult to become accustomed to the new methods and machines.

Always keep yourself well informed of the new machines and methods constantly being introduced, by subscribing to the various mechanical papers published. I can recite numerous instances where I have secured valuable information from the pages of MACHINERY.

Always be accurate in your work—never let it leave your hands in the condition known as "good enough," but make it perfect. It will give you and your employer more satisfaction. It will indirectly bring the best and most accurate work to you, and secure to you the confidence of your employer.

Do not become a specialist, that is an expert on one machine or one line of work only; try if possible to become an all-around mechanic, able to work on the milling machine, shaper, planer, engine or speed lathe, with accuracy and skill. This is very hard to do at present, especially in large places, where the work has been systematized and specialized, for one seeking employment in these large places generally secures it as a lathe, miller, planer, or vise hand. Therefore the advisability of being competent to work on all. In the smaller shops you can generally secure an opportunity to work on all of these machines, but they are usually of an old model, lacking most of the newer accessories.

Therefore, my advice for the young mechanic is to change his positions while young, so that when older, if through loss of position he is compelled to change, he can do so with less worry and more confidence in his abilities.

When entering a new position and securing work upon a machine that you are not familiar with, study it, master its mechanical movements and proceed carefully, taking no chances by throwing in automatic feeds, etc., while the machine is in motion. I have seen numerous so-called good mechanics do this, with disaster, thereby tearing out the tooth of a gear, or breaking some other part of the machine, also losing their positions. If you cannot master the movements of the machine or think them out by yourself, do not fear to ask your foreman or whoever you are working for. Swallow your pride. It is much better to acknowledge your ignorance and ask one or two questions, thereby saving yourself and employer a great amount of delay, trouble and expense for repairs. Do not fear to take advice from some who have had more experience than yourself; you are young and do not know it all. Take the advice, think it over, and if valuable, use it by all means.

Keep your mind only on what you are doing, proceed carefully and be accurate. The skill and speed will come without your being conscious of it, and remember one bad mistake outlives one thousand good pieces of work, for it is generally the mistakes that are remembered by your employer when you ask for an increase in salary. R. L. F.

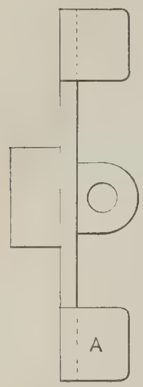


Fig. 1

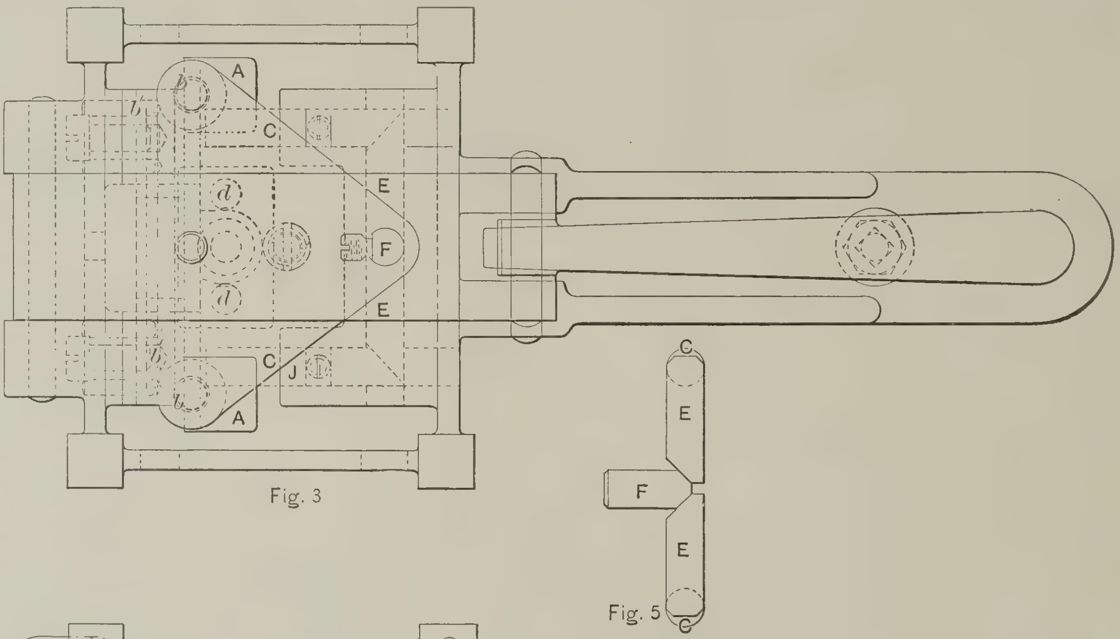


Fig. 3

Fig. 5

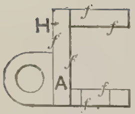
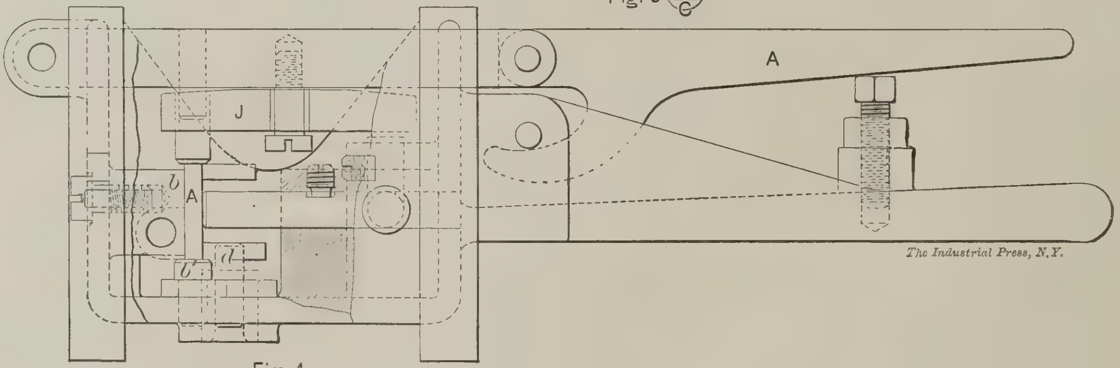


Fig. 2



The Industrial Press, N.Y.

Fig. 4

Drill Jig with Equalizing Clamp for Exactly Locating the Work.

DRILL JIG WITH EQUALIZING CLAMP.

B. P. Fortin.

Editor MACHINERY:

The growing demand for machinery and the competition have necessitated the introduction of improved tools to reduce the cost. Jig and fixture designing has come to be a trade by itself; undoubtedly there is no branch of the mechanical business which requires so much practical experience as in this particular line. A poorly designed tool is a very costly thing; hundreds of dollars can be wasted in a short time with an inferior one. On its accuracy, simplicity and quickness depend quality and quantity, hence cost of product.

There are a number of obstacles to be overcome in accurate jig and fixture designing. The clamping must be done quickly and without springing the jig or the work; then provision must be made for easy cleaning out of chips, and another very important thing is, that it must be so constructed that it will be impossible to get the work in the wrong way. For as I once heard the boss of a manufacturing department say: "If there was any possible way for them to get work in the wrong way they will do it" (meaning the operators). It is important to make drilling jigs as light as possible. To obtain lightness, just as little metal must be used as is necessary to sustain the strain brought to bear upon the parts. All metal should be so placed as to be in line with the strains exerted thereon, therefore, jigs should be box-shape. The advantages obtained are manifold, for, while they are light, they are also easily cleaned. Some of the older manufacturers still advocate the use of heavy drilling jigs—large cumbersome things and slow to handle. Their reason is that a light jig will not stand the rough handling. While that is true in a way, is there any necessity for such rough usage? In my opinion, No! A proper system in the manufacturing department would do away with this.

It is customary in a good many of the large shops in the Eastern States to hire green men and boys to operate their jigs and fixtures. If it is a drilling jig, especially a small one, the gang drill is set up for that purpose, each spindle in rotation is set up for its respective operation. The men that set these machines are competent machinists and they always keep one or more machines set up for the first one who gets out of a job. They are also responsible for the quality and quantity of work turned out. For instance, a drill or reamer may get roughed up and in this manner spoil the work or a drill bushing. Therefore, it keeps the machinists in charge on a constant lookout. The operators are provided with a gage and a sample piece which is correct. They are instructed how to use it; also to try every few pieces to see that they are coming like the sample. In this manner one good man can keep a dozen cheap ones straight.

The design presented in the accompanying illustrations, Figs. 3, 4 and 5, shows clearly the most practical designs and construction for a quick clean jig. Figs. 1 and 2 show a special drop forging, finished at the points indicated by letter *f*; and there were two holes to be drilled at right angles to each other. The jig for drilling the piece is shown with work fastened within it in the plan view, Fig. 3, and the side view, Fig. 4; detail of clamp arrangement, Fig. 5. As the side *H* is the particular side it had to be gaged from that side. The work rests on the gage points, *b b*, and is pushed back against the gage block *b′ b′*. It is located end ways by the two pins *d d*, as there was not sufficient room for a bushing. The drill was guided through block *b′ b′*. The hole drilled from the block had to be very accurate, therefore it was found necessary to run a line reamer through the work. It had a long teat which was guided in the opposite block. This reamer had an end cut only, with sharp corners and two flutes for chips and oil.

The clamping is done by the handle *A* through the opening of the pins, *E E*, *C C*, and *F*. Simultaneously at two points it forces the work down, and also against the block *b′*; at the same time the auxiliary piece or clamp *J* is allowed to float, to take up the slight variation in the piece. Fig. 5 shows clearly how each pin was beveled on the end to push its adjacent pin forward.

The first operation was a drill, fitting the guide hole for a start. Then a drill was run through the work, after that came a rose reamer, then the line reamer. It was the same for the other hole with the exception of the line reamer. The rose reamer in this case finished the hole. A jig of this kind can be used to the best advantage on small finished work. Small rough castings vary so that they make trouble.

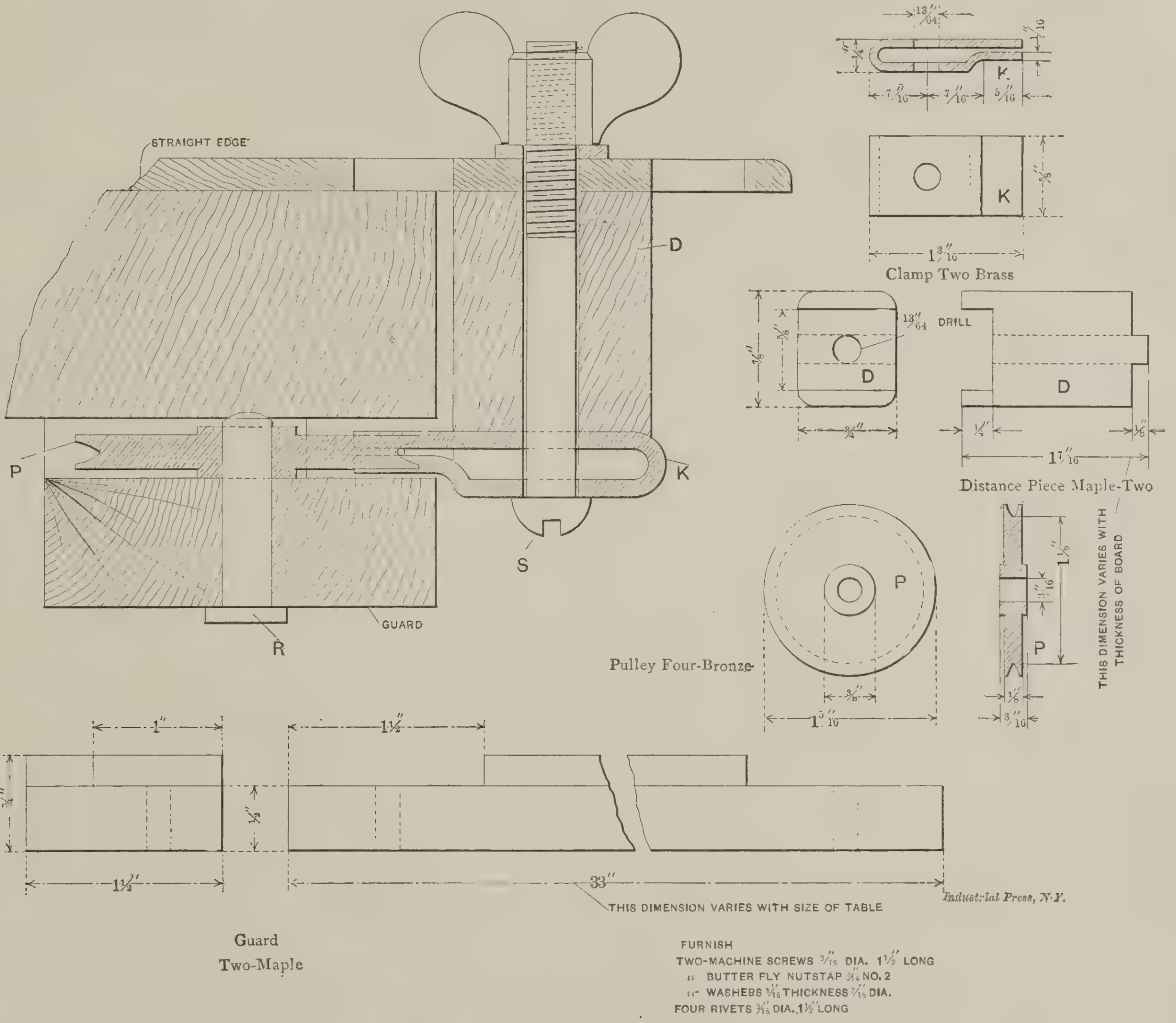
Philadelphia, Pa. B. P. FORTIN.

PARALLEL MOTION FOR DRAFTING TABLES.

Editor MACHINERY:

Some time since it became the duty of the writer to fit up a drafting room, and as parallel motion was desired on all tables, it was necessary that an article be procured that should be of low first cost, accurate in its action, and requiring but a minimum amount of attention. The market was looked over with the idea of buying, but as it was desired to manufacture all apparatus for factory use—provided the cost would not exceed that of the purchased article—the motion illustrated was designed.

The majority of the boards were 33 inches by 55 inches, and were fitted with heavy braces running their entire width (which were drilled out at the proper place to allow the cord to pass freely through) and supporting the adjusting legs. The larger tables were 3 feet by 8 feet and 4 feet by 12 feet. The only change in the entire equipment was in the length of the straightedge, the guard for the cord, and the cord, which was about 1-16 inch diameter. Each end of the board was provided with a guard to protect the cord—as shown in detail—preventing all chance of accident to the cord; it was "rabbeted" to allow free movement of the clamps *K*. This guard also supported the pulleys, and, being firmly attached to the lower side of the board, helped, in a measure, to prevent the tendency of the board to warp.



Industrial Press, N.Y.

Fig. 1. Details of Parallel Motion for Drafting Tables

The straightedges were purchased from a supply house and were slotted at either end, allowing fully one inch in excess of length of the tongue on the distance piece *D*. The binding clamp *K* was made of sheet metal, drilled to a clearance for the binding screw *S* to pass through, and fitted loosely in the distance piece *D*, which was grooved on its lower portion to prevent the clamp *K* from rotating while being tightened, and was tongued on its upper portion to move freely in the slot in the straightedge. This arrangement made it impossible for the clamp to rotate while gripping the cord, and was easily adjusted for the insertion of a new cord; it also made it an easy matter to change the straightedge from the horizontal to an angular position in drawing the conventional screw thread, etc. The pulleys *P* were made of brass, drilled out to rotate freely on the iron rivet *R*, and were grooved to receive the cord. The dimensions given on the illustration are for a board ¾ inch in thickness, and as the board increases in thickness, the length of the distance piece and binding screw will increase in like manner. The cord used is braided linen fish line, and in daily use has worn for two or three years.

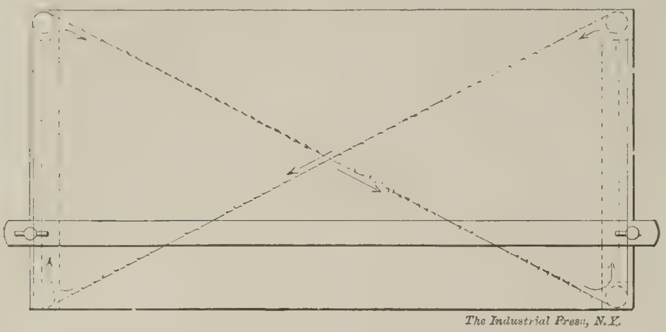

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Fig. 2. Showing Plan of Connections to Straightedge.

The writer does not doubt that there are parallel motions that are as efficient as the one described, but he has used several, and up to the present time has not found any that are more convenient and certainly none that cost less.

V. A. H.

ACCURATE JIG MAKING.

Editor MACHINERY:

I have just read with a good deal of interest the article on jig making by Mr. Frank E. Shailor in the July issue of MACHINERY, and having myself used the methods of spacing the holes he describes, can vouch for their accuracy, when the conditions for doing the work are right. Toolmakers who have worked in a number of shops, however, can testify that milling machines with corrected screws are mighty scarce, and also that in some shops where great accuracy in the work is demanded, the machine equipment is sadly deficient in the qualities most needed for accurate work. I have in mind a shop in Brooklyn in which I worked for several months, where the limit of error was 0.001 inch in parts of the work, and 0.0001 inch in other parts of the work, and whose tool equipment was worn so badly from years of usage, as to make the use of the feed screws out of the question for accurate work.

However accurate a screw is on a milling machine when new, it soon loses its truth if used under the ordinary conditions of machine shop practice, since only a small portion of the screw is used to do most of the work of driving the table, and that too under all conditions of cut and feed. Now I would have nothing to say against this method if I knew of none better, but I think the method of spacing holes in jig plates that I described in the October, 1902, number of MACHINERY is the better of the two, and believe it should be brought to the attention of your readers again.

This method is one by which the plates are placed on the table of a drill press of the sensitive, or semi-sensitive type, depending on the size of the plates to be drilled, and held to position by gages, readily and cheaply made, and the position of the bushing is spotted by a pilot drill guided by a bushing, which is in turn held by a bracket fastened to the frame of the drill press. The pilot drill is driven in, only about one and a half times its diameter at first, to avoid making too many chips, the holes being drilled through after the bushing bracket is removed.

I have tried two methods of opening the holes to the reamer size, both of which proved to be good, but the first required a little more care than the second. The first consisted of using the half-round 60-degree center reamer to open the mouth of the hole to a diameter slightly greater than the reamer size, and then drilling out to reaming size with a drill very carefully ground to have its cutting lips even. The drill should be quite short and run true in the chuck. The second method consisted of using a counterbore having a pilot that fits the hole made by the pilot drill, and counterboring the hole out, leaving enough metal for the reamer which is to size the hole for the bushings, in both methods.

The advantages of this system over that of the milling machine and button methods are many and apparent after a little study. One advantage is in getting ready, the supposition being that the main parts, such as parallels, bracket, bushing, etc., are made. A second advantage is the slight chance of error in making the changes, if the gages are marked distinctly. Again, nearly all shops contain an equipment that will permit the use of this method, with but little outlay for getting ready. The gages are made of brass, steel, or iron, the length being obtained by micrometer or vernier calipers, and if the plates are small, no change is necessary in the drill press arrangement, except the making of the bushing bracket.

I once worked in a shop where the back-lash on the feed screw of the milling machine was at one point nearly a quarter revolution of the screw and at the end was quite a nice fit, the machine being quite old. I had a job to do that required very nice measurements, and succeeded by using the stop on the table, and making gages of drill rod to give me the distances to move.

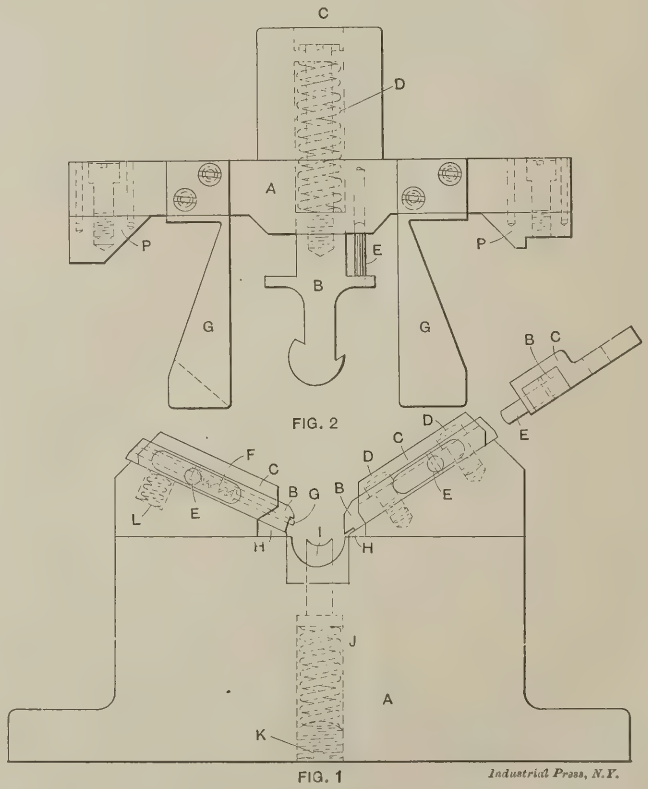
J. R. GORDON.

Brooklyn, N. Y.

PUNCH AND DIE FOR MAKING HINGE SPRINGS FOR NOVELTY BOXES.

Editor MACHINERY:

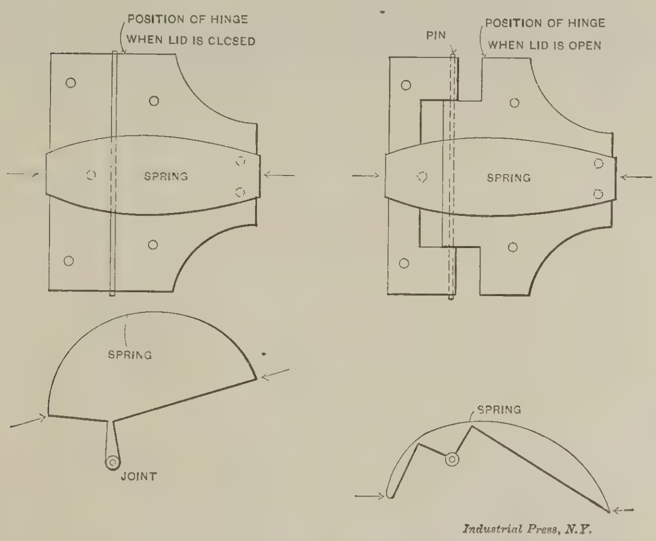
The cut Figs. 1 and 2 illustrates a punch and die for bending a sheet steel piece to the shape of the spring shown in Figs. 3 and 4. This piece was afterwards given a spring temper and was used as such. The spring in question is used on small novelty boxes—such as jewelry boxes, etc.—it being snapped on the hinge to prevent the cover of the box being thrown back beyond a vertical position, and also to keep it closed with some little tension when down. The demand for these springs was such as to warrant the making of the punch and die for the purpose of adapting it to the rapid handling and bending of the spring complete at one stroke of the press. The spring is made from high carbon sheet steel 0.012 inch thick, which was first blanked out in a cutting die the required outline and length.



Industrial Press, N.Y.

Punch and Die for Making Hinge Springs.

Those who have essayed bending tool steel in a die for the first time have probably not been pleased with the experiment, and usually not satisfied with their success, especially when a high degree of accuracy is required. In this instance, moreover, the difficulty of developing the exact shape and the added difficulties of securing successive lots of steel of the proper carbon and anneal to make the continuous production the attainment of uniformity, grow very rapidly in the production of a piece of this type; even with previous experience on this class of work we were forced to make two or three of the pieces that constitute the forming die, and experiment considerably before the perfect development was reached. An experienced punch press hand is essential to operate a die of this kind. It is pretty safe to say that in a tool of this design when two blanks, one on top of the other, are put in the die—which is seldom—that something will happen. We experienced this misfortune soon after constructing our first die, and the chances are, as was the case with us, that a new die will be cheaper than attempting to repair the old one.


POSITION OF HINGE WHEN LID IS CLOSED
PIN
POSITION OF HINGE WHEN LID IS OPEN
SPRING
SPRING
SPRING
JOINT
SPRING
Industrial Press, N.Y.

Figs 3 and 4. The Spring Hinge shown in Closed and Open Positions.

The use of the cams to move the slides outward we find is particularly better than springs, in view of their positive action, which decreases to a minimum the liability of an accident. An accident in this type of die is self-evident should the slides for any reason be in a position with their inner ends over the shoulders on the punch during the upward movement of the press ram. The capacity of these cams for this particular type of die is extensive. Of course, the angle is measured according to the movement of the press ram; it can be varied up to 45 degrees.

The punch and dies shown in the illustration and now to be described consist of the die, Fig. 1, and the punch, Fig. 2. The base *A*, Fig. 1, is of cast iron and carries the rectangular hardened steel slides *B B* secured thereon by caps *C C* and four 5-16-inch filister head screws *D D*. The two screws in the left cap are omitted for the sake of clearness in the drawing. The front of the caps are provided with elongated slots through which project the hardened ¼-inch pins *E E* that engage with the cams on the punch to throw the slides outward. The pins extending through the slides are retained rigidly in place by small pins driven through them. The pin in the left slide insures the maintenance of the spring *F* and sliding pin *G* in proper position. The base *A* is cut away at *H H* to gage the work. On the downward action of the press the steel blank is clamped between the punch and the square piece *I*, which is supported by the compression spring *J*. Directly beneath it, to provide for the adjustment of the tension the blind screw *K* is provided. To provide for and control the necessary steady action of the slides, and to prevent a loose movement, which must naturally take place after a short run on account of their inclined position, a spring *L* is located beneath each slide, the one on the left only being shown in the sketch. The right spring is omitted to avoid obscurity.

Fig. 2 shows the punch in detail: *A* is the holder, *B* the punch proper, held in its downwardly extended position by the screw *C*. Back of the former is the stiff spring *D*, essentially of a strength sufficient to bend the blank down in the die before any perceptible contraction takes place. Pin *E*, with the upper end fitted freely in the holder keeps the part *B* from rotating. The inclined faced pieces *P P*, fastened to the holder by screws and dowel pins, on the extreme downward movement of the ram, force the slides in and make the sharp end bends on the work. Seated in the holder to insure true parallelism and angular displacement, and secured thereto by screws are the cams *G G* made from ¼-inch thick tool steel, with their working surfaces hardened to obviate abrasion. They project forward just sufficient to pass down and close to the front of the die, where they engage with projecting pins in the slides. When the punch is up to its extreme height the lower ends of the cams are in contact with the pins; in fact, they are never entirely clear of the die. When the press carries the punch up beyond the die we usually machine away the lower corners of *G G* at about the same angle, as shown by the dotted line on the left-hand piece, to avoid striking abruptly on the pin in the slide, if for some accidental reason they should chance to be in when the press is tripped.

All working parts of the punch and die were hardened and drawn, as is consistent with good practice, to insure the life of the same. The press is run at a high rate and tipped back on an incline, as the expansion of the work was sufficient to allow it to fall by gravity from off the punch, and therefore allowing the blanks to be constantly fed to the die, increasing materially the daily production.

C. H. Rowe.

Worcester, Mass.

LATHE ROLLER FOR FINISHING SURFACES.

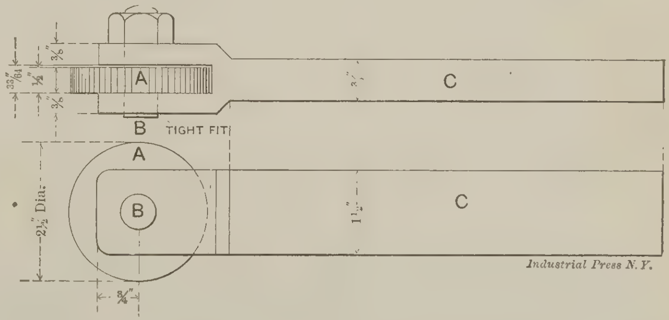
Editor Machinery:

We have in use at the shop I am connected with at present a lathe tool which can be very easily and cheaply made and would, I am sure, be appreciated by at least some of your readers, for while we use it here, it seems a new thing to most machinists who come to our shop. The enclosed sketch is self-explanatory.

Roller *A* is of tool steel turned and hardened and revolves freely on pin *B*, while yoke *C* is a steel forging. After the ordinary roughing cut is taken practically to size, this tool is placed in the tool-post and brought to bear quite firmly against the piece being turned and fed for the length of surface required to be polished. The result will, I am sure, both surprise and please any one who has not used this tool before. This tool gives a more satisfactory finish to a shaft than any other way I know of, for it not only insures the shaft being perfectly true but it seems to harden the surface of the shaft so as to make a very noticeable difference in the life of same. I trust that this will be given a trial by those who have never before used it. The dimensions given are not arbitrary but work well.

R. F. Kiefer.

Cleveland, O.



Lathe Roller for Finishing Turned Surfaces.

[Undoubtedly this tool will be new to many as it was to our correspondent, but it is one that has been quite popular in locomotive repair and building shops for years. Its chief use in such shops has been for smoothing and compressing the surfaces of journals, and for finishing piston rods and valve stems. Driving axle journals finished by rolling generally run cool from the start and they wear considerably longer than when file-finished. The turned surface should, however, be as true as possible before rolling for, while the roller does tend to correct local inequalities, it does not correct a general want of truth, as is the case with the grinding machine.—Editor.]

BORING BAR ATTACHMENT FOR PLANER.

Editor MACHINERY:

The superintendent of the Riehle Bros. Testing Machine Co.'s works in Philadelphia, Mr. W. J. Tretch, having occasion recently to do a heavy job of boring devised the rig shown in the accompanying sketch, utilizing one of the shop planers as a horizontal boring machine. A portable drill press *C*, Fig. 2, bolted to the back side of the cross-rail, furnishes driving power. In the Riehle works the power is supplied to this press from one of the several rope drives which, stationed at convenient intervals, furnish power to portable tools on the erecting floor. Power could be supplied as well from an electric motor or a special countershaft. To the apron of the planer is bolted a yoke *B*, which carries the bearings for the boring bar *D*. The journals are large cast iron sleeves fitted to the boring bar by a sliding key; the key-way extends the full length of the bar. By this means amply large bearing surfaces are secured, rigidity is given to the bar, and the bar itself does not wear in use. The tail support *E* is a similar bearing supported by a slotted angle piece which is bolted to the planer table.

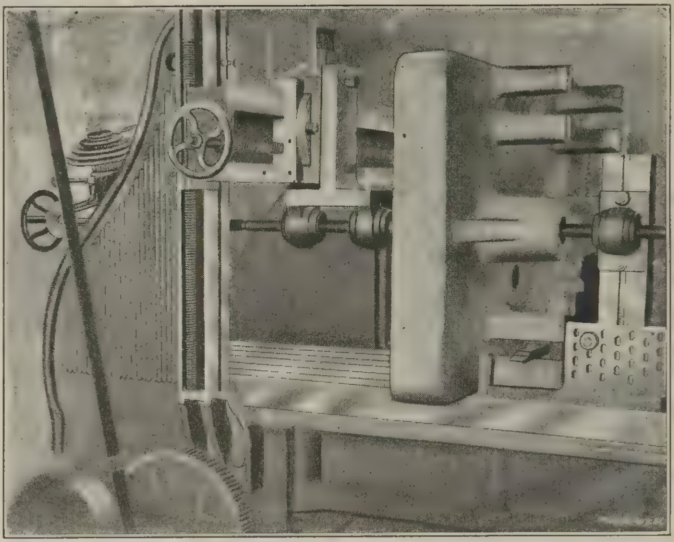


Fig. 1. Front View of Boring Bar and Job on Planer.

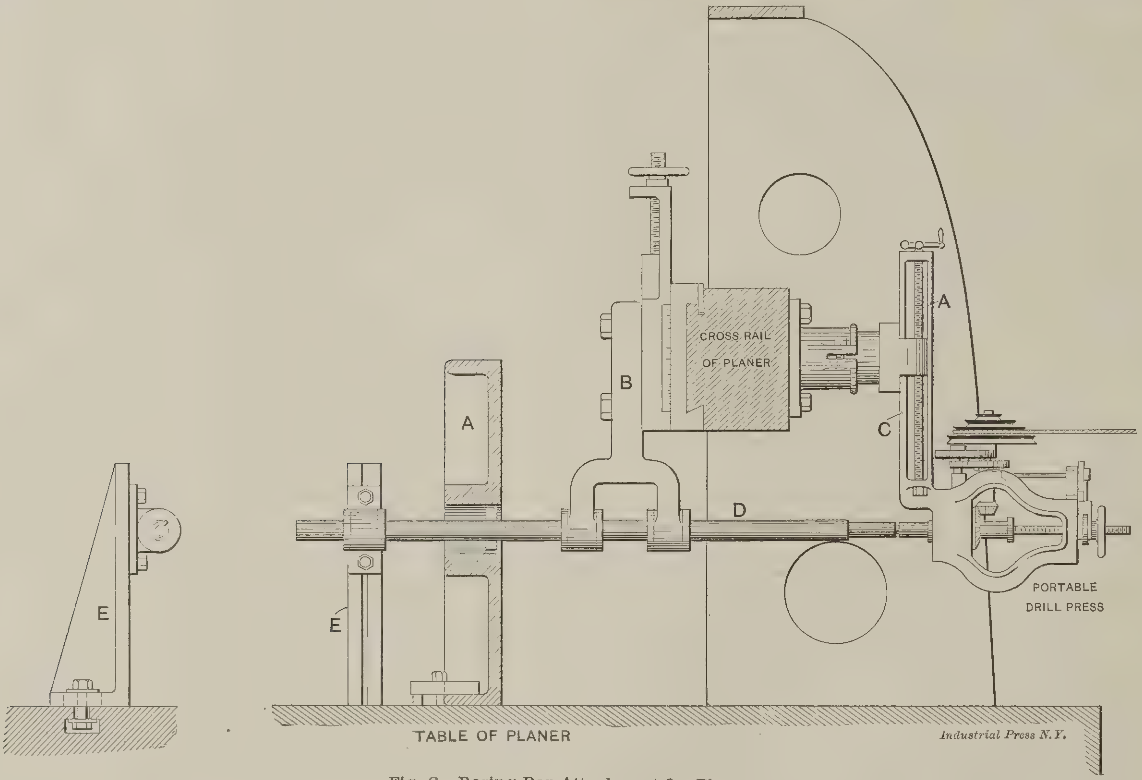


Fig. 2. Boring Bar Attachment for Planer.

The apparatus has given excellent satisfaction in the Riehle shops, being frequently used since its first installation. The above attachment would be specially useful to those shops which have occasional use for a horizontal boring mill, but not frequent enough to use to justify the purchase of that expensive piece of apparatus. With a 2-inch bar holes up to 10 inches in diameter can be bored.

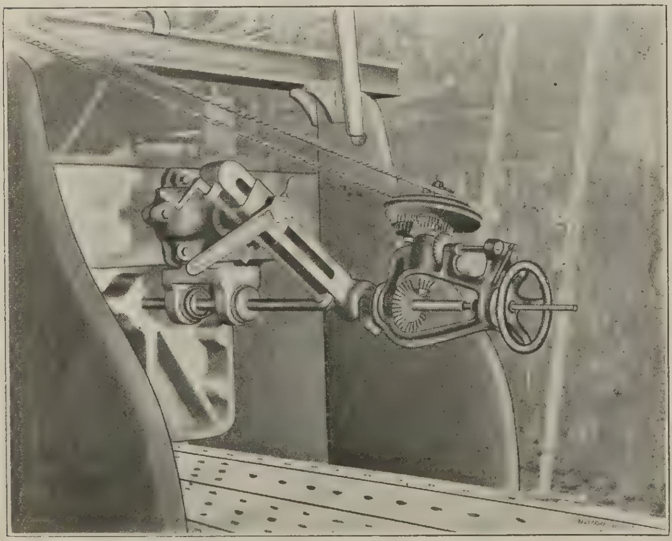


Fig 3. Rear View of Boring Bar on Planer

Philadelphia, Pa. H. F. MOORE.

ANNEALING HARDENED STEEL LOCALLY.

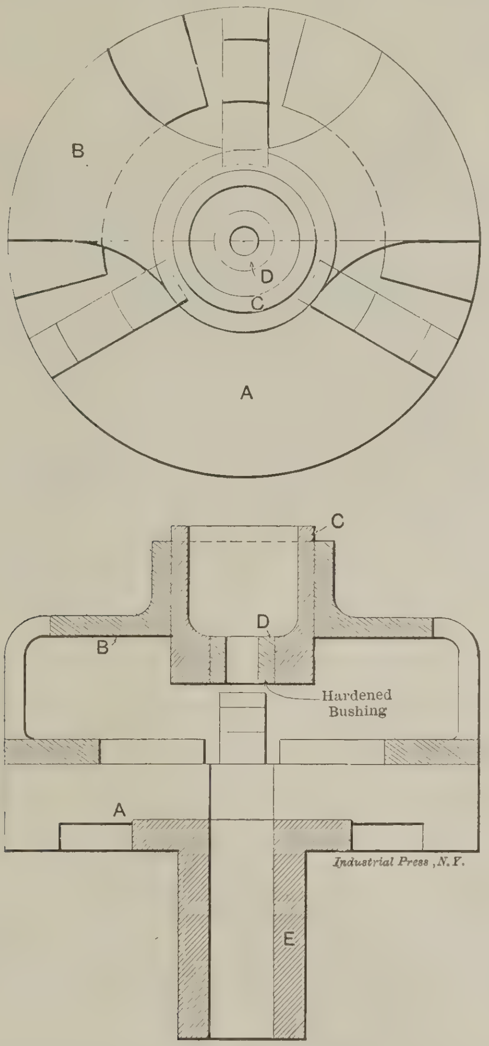
Editor MACHINERY:

The articles which you have been publishing from F. J. K. and Harry Ash in regard to the annealing of hard spots in steel or softening limited areas in hard steel have interested me somewhat, although there are simpler and more practical methods by which the desired results may be obtained. I have in mind two methods which may be used to advantage in work of this character, and either of which I consider superior to those previously suggested by F. J. K. and Harry Ash, although their suggestions are good.

Where a hard spot is encountered in a piece which is desired soft throughout, the piece may be held in a fine gas blast which almost any shop or mechanical room is provided with. This will very readily bring that portion of the piece to which the blast is applied to a soft condition, and will work equally well where it is desired to soften a spot in a hard surface or hardened section for the drilling of holes, tapping, etc. By regulating the heat given the piece, almost any degree of softness desired may be obtained.

Where a gas blast cannot be conveniently procured, an extremely effectual and simple method is to place a small ring over the spot that it is desired to soften, and then pour molten lead into the ring. This, of course, brings the molten metal in contact with the hard spot or surface, the ring preventing the lead from flowing beyond the point being treated, and confining the softening to the space desired annealed. The degree of the softness desired can be regulated by the capacity of the ring, a considerable quantity of lead bringing about a very soft condition. If only a slightly annealed space is desired, a small quantity of the molten lead will do the work. To one who has never tried this method of annealing a spot, it will be surprising to note what may be accomplished by the application of the heated lead. In a machine shop it will often be found desirable to have a certain portion of a hardened piece annealed slightly for cutting a key-way, drilling a hole, or other machining where it is not desirable to subject the entire piece to the annealing heat, and in such instances molten lead can be used most advantageously.

Irm J.



Jig for Boring Rough Castings.

ANOTHER JIG FOR BORING ROUGH CASTINGS.

Editor Machinery:

Referring to the letter in the June issue of Machinery by Mr. Cyril B. Clark in which he describes a jig for boring rough castings, containing three moving jaws, the way we bore gears and sprocket is as follows:

We took a 15-inch three-jaw combination chuck *A* and fitted over it the casting *B*, which holds the large cast iron bushing *C*. By making the stem *E* of the chuck faceplate of the same size as the stem of the drill press table, the jig is quickly centered. The large bushing *C* holds another smaller bushing *D* which is hardened and which serves to guide the drills. The small bushing is readily removable and can be exchanged for others as the work may require. We use three-groove chucking reamers with this jig, as all our castings are cored. This arrangement gives us a jig that will hold all sizes of castings that will go into the chuck.

Fred Ginkel.

Syracuse, N. Y.

RUSTLESS SOLDERING SOLUTION.

Editor Machinery:

Replying further to C. W. B.'s inquiry for a rustless soldering solution I have at hand a formula which is claimed to be rustless, but I have never tested it. It is simply a saturated solution of zinc chloride in grain alcohol.

In using a rustless soldering solution, care should be taken to have a soldering bit that has never been used with acid, as the copper absorbs enough acid to cause the work to rust even though the solution is a rustless one.

Syracuse, N. Y. George G. Porter.

USE OF CARBORUNDUM WHEELS.

Editor Machinery:

For tests of their merit I have been grinding and experimenting with the different grits and bonds of these wheels on all sorts of stock, such as hard and soft steel, cast iron, cast steel, malleable and chilled iron, brass, bronze, aluminum, slate, the various grades of rubber, wood fiber, cork, glass, granite, china, stone, brick, leather, wood, asbestos, carbon, in short, almost everything used in the arts and for manufacturing purposes. I have even successfully ground the ends of the bristles on a reel brush, one inch or more in length, making a true and even surface.

As there is a difference of opinion, it may be of interest to users of these wheels to learn, from practical experiments made, which is the proper way of grinding paper, planer or other knives. Some claim the knife should be set with the cutting edge toward the motion of the wheel; others from the motion. In my tests made on this work, I find that without doubt or question the proper way is to run the wheel toward the cutting edge, and with the edge up. After a number of tests made both ways, I soon found trouble with the same wheel on the same work, in running the wheel from the cutting edge because of glazing, and heating the knife, which, of course, follows after glazing. While running toward the cutting edge there was no trouble from either glazing or heating. From close observation I find this is accounted for in this way. When the wheel runs toward the cutting edge (the proper way) it removes the tempered or hardened portion of the knife first and these hardened particles are carried down between the wheel and the softer portion of the knife, assisting the wheel in removing the softer portion and keeping the interstices of the wheel open and cutting qualities in good shape. When we set the knife with its cutting edge (the hardened portion) from the motion of the wheel and we first remove the softer portion of the knife, the particles of which have little abrasive power, and as they are carried down between the wheel and the hardened portion, they obstruct its cutting qualities by being rubbed or pressed into the pores or cutting cavities. This soon fills them up and glazes the wheel, acting the opposite to what it does in running toward the cutting edge (the proper way). I will be glad to hear from any one interested in grinding about this or any other points of interest, and I hope to give further interesting facts regarding the carborundum wheels later on.

Ezra F. Landis.

La Salle, N. Y.

A CRITICISM.

Editor Machinery:

In the first article of the present series on "Tool-Making," by E. R. Markham, he asks the experienced toolmakers to overlook that which he writes, as it is intended only for apprentices. I think it is bad practice to set forth methods and appliances intended to enlighten the apprentices if in after years the apprentice is obliged to discard the primitive teaching and begin anew. For this reason I take exception to the statements by Mr. Markham that I know from actual experience will prove misleading to the apprentices of to-day.

For instance, in making a screw-cutting die, Mr. Markham advocates the use of a screw that fits tightly in the die while drilling the clearance holes around die. I claim that a screw tightened in a soft die to that degree of tension necessary to prevent the screw from turning when drilling the clearance holes will stretch the thread. After hardening the die, the lead will change again and invariably one error multiplies the other, producing a die the lead of which is far from that intended.

Again, Mr. Markham carefully leads the inexperienced along, pointing out this and that which should be avoided, and at the critical point discards the use of care entirely, and proceeds in such a manner that if the work produced is true, it is "bull luck" and nothing else. I refer to his description of accurately locating the center of a thread-cutting die. Mr. Markham says: "After truing faceplate and carefully indicating the prick punch mark (even the necessary precaution of removing the belt to prevent lacing vibrating lathe), proceed to drill the hole. After drilling the hole, bore it to desired size *unless* a reamer is at hand that will produce the desired tap size hole."

My advice to apprentices is, never ream a *drilled* hole if said hole is of a nature that it is necessary to indicate same in a lathe. The drill may start perfectly true, but it is once out of a thousand that it continues true clear through the work. Hard spots in steel, drill becoming dull, one lip doing a trifle more cutting than the other and crowding the drill, are elements that will tend to make the drill "crawl" away from the center. I have seen a reamer cause a hole to run out of true when used simply to size hole after boring. Probably there was a dull tooth on the reamer, but nevertheless *bore* all holes when the hole is desired central with work.

In my opinion, apprentices should be taught the most modern methods that help to produce accurate work, for the degree of accuracy that the toolmaker of to-day is obliged to work to is such that the best methods known are none too good.

Great Barrington, Mass. FRANK E. SHAILOR.

FROM THE INVENTOR OF THE TOOL FOR LAYING OUT HEXAGONS.

Editor MACHINERY:

The tool for laying out hexagons on the ends of rounds for patternmakers' use, shown in the July issue of MACHINERY, was invented by me over twenty-five years ago while working for Rumsey & Co., Seneca Falls, N. Y., pump manufacturers, for laying out the hexagon caps used on pump cylinders. Shortly after I removed to Ohio and made and sold some of them to patternmakers, and no doubt there is a large number of them in use among patternmakers. The included angle between the wooden side *C* must be very accurate, as any error is doubled in laying out, and it is necessary to use a very sharp pencil. G. E. BABCOCK.

Fort Plain, N. Y.

[In this connection it may be noted that an omission occurred in the cut, Fig. 2, which accompanied the editorial comment on this tool. A line corresponding to *BJ* should have appeared below *BL*, drawn from *B* and tangent to the outer circle, since the angle 70 degrees 32 minutes is included between these tangent lines and not between *BJ* and *BL*, as accidentally appeared in the cut.—EDITOR.]

FACING STUDS FOR LATHE CHUCKS.

Editor MACHINERY:

I send you to-day sketches of a handy little appliance that I call a facing stud, and one which I have found to be worth its weight in gold when used for facing flat disks in the lathe. I have had to make a large number of steel disks ⅜-inch thick by 11 inches diameter and have used the studs to great advantage. The studs are made of machine steel as shown in Figs. 1, 2 and 3. Fig. 4 shows a set of the studs in position in a chuck. They may be used with either a three or a four jaw chuck, placing one of the studs in each of the T-slots found in nearly all chucks.

Having plenty of stock on the rough disks, during the first operation I held them in the jaws of the chuck with as short a grip as possible, and was thus enabled to finish-bore and turn them, also to take a rough cut over the face. For the second operation, the studs having been placed in position and faced off true, the opposite side of the disk was then faced to within 1-32 inch of finished thickness, this operation taking off the stock held by the jaws of the chuck during the first operation. The studs were then faced again, to insure their being correct, the disks placed in the chuck very carefully, bearing against the studs, and a cut taken off each side to the right thickness.

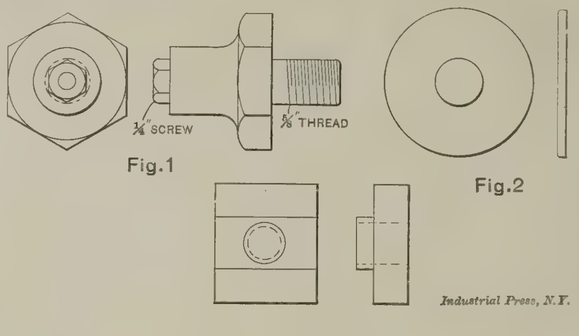


Fig.3

Facing Studs for Lathe Chucks

In chucking the disks for the last operation I was surprised and gratified to find how little pressure of the jaws was needed to hold the disks in place, as too much pressure would spring the disk and spoil the job. In a lot of 25 disks, the greatest variation found by the inspector was 0.001 inch.

The ¼ inch cap screws inserted in the end of the studs can be removed when faced thin and replaced with new ones. I would add that neither the outside diameter nor the bore of these disks was required to be very exact. In re-chucking after the first operation, it was not necessary to true the disk edgewise very closely. RALPH B. CASEY.

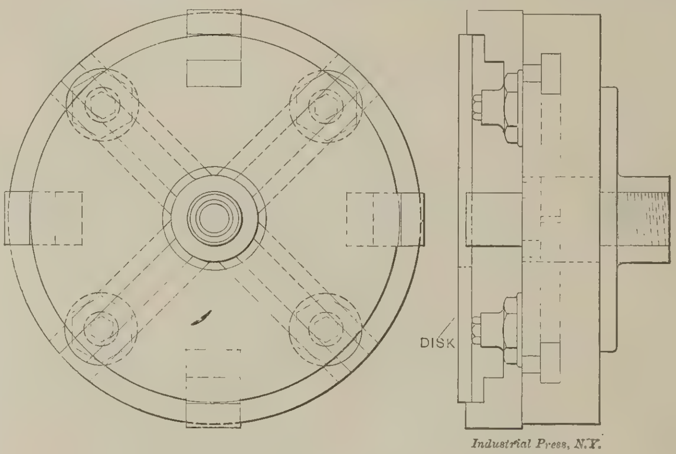


Fig. 4. Set of Facing Studs shown in Position in Chuck.

Schenectady, N. Y.

* * *

A general knowledge of economical methods of making engine repairs, is a very valuable asset for a chief engineer. In fact he cannot fill the position in many power plants unless he does have this qualification. If a part becomes worn so that it cannot properly perform its function it is the natural impulse to replace it with another—and usually a costly impulse, too. Right here is where the skilled engineer and a "starter-and-stopper" will differentiate; in many cases the old part can be made to serve its purpose as well as a new one if the engineer in charge has the "know how." For instance, suppose the key connecting the piston rod to the crosshead is found to have worn in the rod so that it does not draw the rod into the taper fit, although it fits tightly in the crosshead and cannot be driven in any further. It is not usually necessary to throw away the key found in this condition, and make a new one. A good blacksmith can spread such a key so that it will dress down straight on the worn edge, and serve all practical purposes. The key is not widened by flattening the whole surface as this would make it thinner than the width of the key slot, but a narrow fuller is laid longitudinally along the center of the key, thus forming a shallow groove. The displacement of metal in the center in this way will easily spread a steel key all that is required in most cases.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

HENDEY CENTERING MACHINE.

The accompanying illustrations show a new centering machine brought out by the Hendey Machine Co., Torrington, Conn. This machine was not at first intended for market. One was originally designed and made at the Hendey shops to meet their own requirements for a centering machine, but it has been found so useful, and so well adapted to the work intended, that it is believed it will also meet the requirements of many other firms, and so it has been decided to place the machine on the market. Accordingly a lot of these machines have been completed and are now on hand ready for prompt delivery.

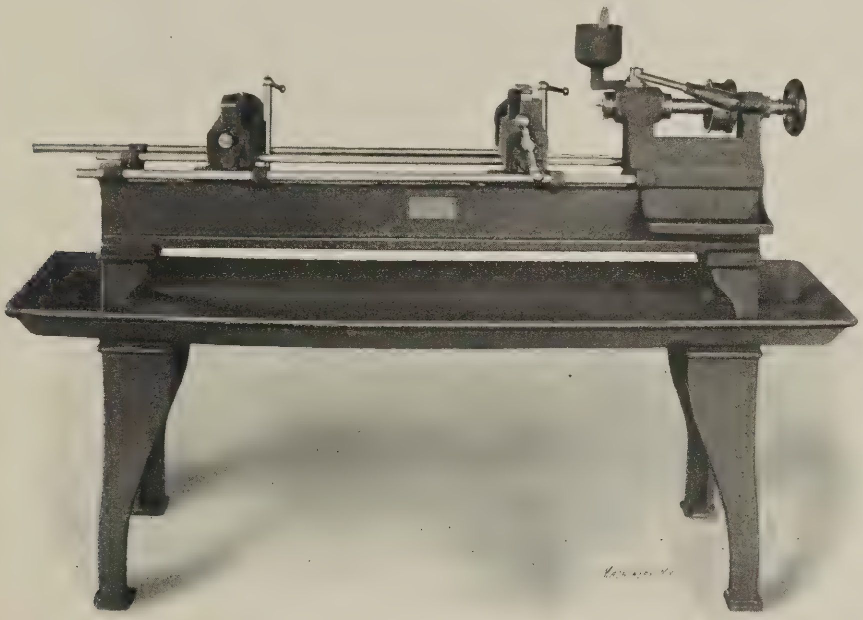


Fig. 1. Centering Machine made by Hendey Machine Company.

The machine is built with a rigid head having a single spindle permanently aligned with the ways of the machine, and large in diameter with ample bearings. The spindle is provided with a draw-in attachment with a watch-tool chuck for accurately and conveniently gripping a combination center drill and reamer. The front bearing of the spindle is made taper, after the well-known pattern of the Hendey-Norton lathe head, and the spindle is provided with a back locking pin for use when necessary to remove or replace the center drill.

The jaws of vise and supporting block are made of tool steel, hardened and ground, and aligned true from bar placed in the spindle of the machine. This care in alignment is exercised in order to enable the machine to accurately center stock for finishing purposes after coming from the turret lathe or screw machine. This was one of the active requirements of a centering machine as found in the every-day work of the shops.

The block and vise work in unison, controlled from the one ball handle, the two being kept in proper relation by means of the rod and spiral-geared drive located at back of the machine. This means that, no matter what diameter the bar may be within the limits of the machine, it will always be supported in a horizontal position, there being no hand adjustment and "eye alignment" necessary for back support, as usually required.

The inclined surface of the bed, sloping away from operator, tends to direct the chips into the pan, rather than have them accumulate around the head, necessitating frequent cleanings when it is desired to shift the carriage or saddle.

The heavy parallel bars, running the length of the machine serve the two-fold purpose of a rack for carrying stock to be centered, and, in connection with the inclined bed, prevent the common use of bed as a temporary support for the stock and the consequent bruising and banging of the bed which often throw the rear supporting block out of alignment.

The saddles are gibbed and fitted to bed, and provided with binding handles for ready clamping in position.

The machine is designed to handle stock from 5-16 inch to 3¼ inches inclusive. While many centering machines take up to 4 inches or even larger in diameter, the range of the machine is ample enough to cover all the needs of the larger portion of the centering work in the majority of shops, and will avoid the necessarily destructive influences exercised on any centering machine where they are called upon to handle bars weighing upward of 300 or 400 pounds each.

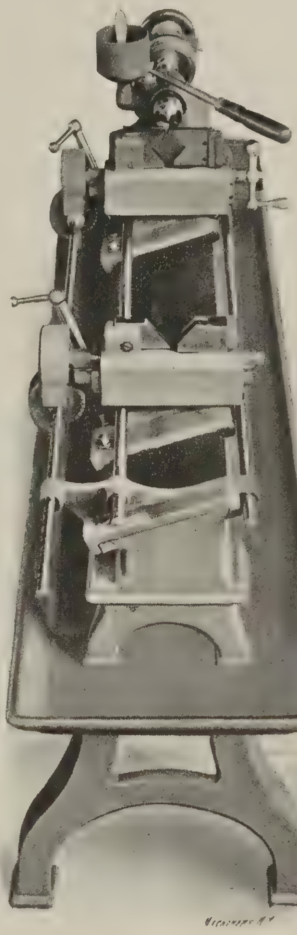


Fig. 2. View looking from Above.

The general dimensions of this machine are: Spindle bearing, front, taper, 1⅜ inch to 1 9-16 inch by 4¼ inches long; spindle bearing, rear, 1 3-16 inches by 3¼ inches long; length of bed, 4 feet 6 inches; greatest distance between vise and block, 34½ inches; capacity of vise, 5-16 inch to 3¼ inches; diameter friction pulley on countershaft, 10 inches; speed of countershaft, 300 R.P.M.; speed of machine, 1,000 R.P.M; floor space required, 69 inches by 21 inches; weight, net, 800 pounds.

QUICK CHANGE DEVICE FOR ENGINE LATHES.

The quick change device shown in Figs. 1 and 2, next page, for varying the feed, or lead of screws cut, has been adopted after a thorough test, by the New Haven Mfg. Co., New Haven, Conn., for its line of engine lathes of 32-inch swing and larger, and essentially in the same form for the lathes of 18-inch to 28-inch swing, with the exception that on the lathes below 32-inch swing it is given a wider range of change because of the additional changes provided at the end of the headstock.

The device includes a nest of seven bevel gears *L* mounted on the leadscrew shaft *P*. Above this nest of bevel gears is a bevel pinion *B* mounted on the quill *G* so that it can be moved longitudinally to permit of its being engaged with any one of the seven gears below it. The quill is splined to convey motion to the pinion *B*, and it is driven by the bevel pinion

F keyed on the end. *F*, in turn, receives its motion from the bevel pinion *E*, which is mounted on the change gear shaft and which carries at its outer end change gear *C*. The shaft *H* supporting the quill *G*, is mounted in two eccentrics *J J*, which give the bevel pinion *B* an in-and-out motion relative to the nest of gears when manipulated by the handle *K* for changing the gear ratio. The sliding pinion *B* is moved longitudinally to the position indicated by the index plate for the desired thread or feed, by means of the knob *M*, and after being engaged with the desired gear, is held in position by the pin *N*. This pin enters a hole marked with the number of teeth of the gear with which the pinion is engaged, being, for instance, 48 in Fig. 2. This provides quick changes by steps between and including the ratio 32 to 56.

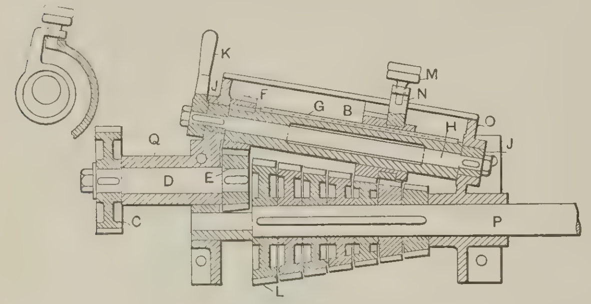


Fig. 1. SECTION THROUGH GEARS AND ECCENTRIC MECHANISM

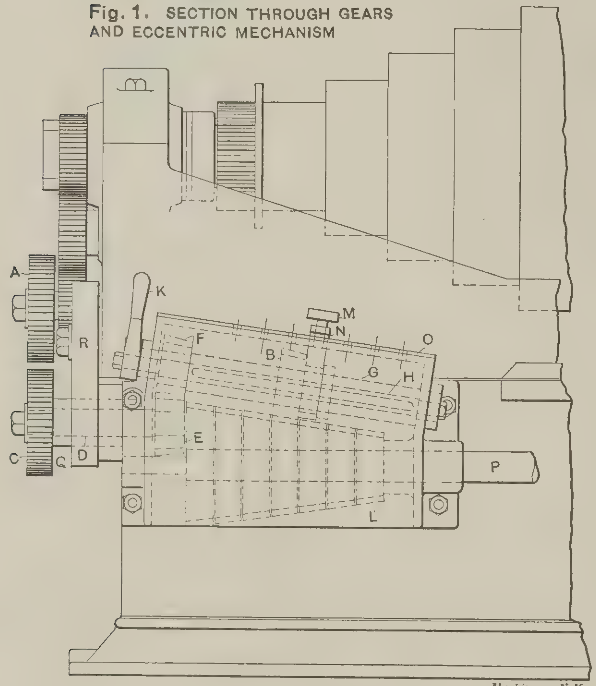


Fig. 2. SIDE ELEVATION

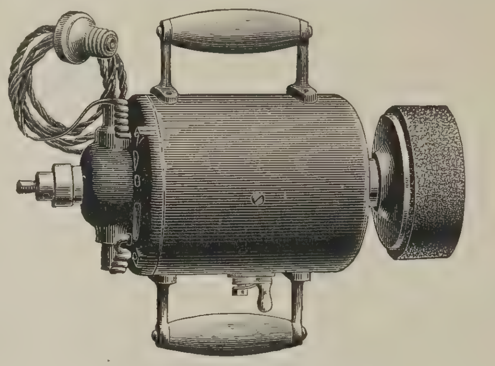
Machinery, N.Y.

Change Gear Device of New Haven Mfg. Company.

For wider ranges on the lathes of 32-inch swing and larger, a stud-plate *R* is mounted on the hub *Q* at the left end of the gear box *O* carrying gears so arranged that threads from 2 to 14 may be cut, or feeds from 8 to 56 obtained without changing the position of the intermediate stud, the gears being so proportioned that as one is removed from change gear shaft *E* it is used as the intermediate gear, and so on. Open washers are used on the ends of the studs so that no nuts have to be removed, thus making this portion of the change easily and quickly effected. On lathes of 18- to 28-inch swing, inclusive, four additional changes are provided. This is effected by adjusting gear *A* longitudinally, permitting it to be meshed with either of the intermediate gears, the intermediate gear in this case being compound; and by mounting two gears at *C* on the change gear shaft. These are of different diameters and both mesh with the compound intermediate gear. A sliding spring key is provided by which either gear can be thrown into clutch with the shaft, thus giving the four changes without changing gears, the stud-plate having to be shifted on its pivot for two of the changes. This gives a range from 1 to 15 threads per inch and feeds from 4 to 60 per inch inclusive. By changing gear *A* other changes, of course, are readily obtained.

PORTABLE ELECTRIC GRINDER.

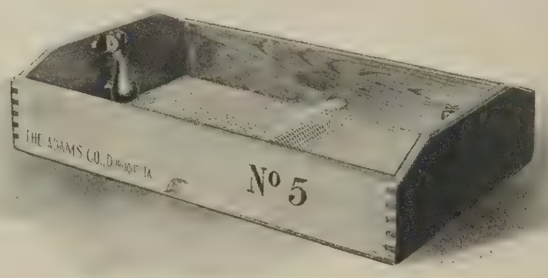
The Hisey-Wolf Machine Co., Cincinnati, O., have added to their line of portable electric tools an electrically-driven hand buffer or grinder which is shown herewith. It is adapted for buffing, polishing, grinding, sanding or other work of this nature. It is light in weight and can be attached to any electric light socket with a cord of any length necessary to reach the work. The motor is enclosed and dust-proof and the bearings are adjustable for wear. The motor is under the control of the operator at all times by a suitably located switch, and two handles are located diametrically opposite, enabling the operator to hold the grinder firmly and to manipulate it to advantage. Any kind of wheel can be attached for either buffing or grinding.



Portable Grinder and Buffer.

FOUNDRY RIDDLE.

A new riddle for molders' use has just been brought out by the Adams Company, Dubuque, Iowa, which is illustrated herewith. This was designed with two objects in view, i. e., to riddle all or very nearly all the sand into the flask (not half of it on the floor) hence the oblong shape; and to riddle the sand faster with less work. The latter end is gained by providing a small iron clapper on the inside of each end of the riddle in such a way that when the molder shakes the riddle back and forth, the clappers automatically vibrate or jar the riddle. It is stated that the results are surprising. The riddle is well made and is very durable; the rapping of the clappers keeps the wire screen clean and the wire can be easily and quickly replaced when worn out. A raised rib in center of riddle serves to break up the large lumps of sand more quickly.



Riddle for Molders.

This riddle is made in one standard size, 11 x 18 inside, but other sizes can be made for special requirements.

LODGE & SHIPLEY HIGH-SPEED LATHE.

The Lodge & Shipley Machine Tool Co., Cincinnati, O., have produced a new type of lathe head, for use with high-speed steel, especially designed to stand the hard abuse to which such a machine is subjected. There is a single belt pulley attached to a sleeve through which the spindle passes. The hole through the sleeve is ⅛ inch larger in diameter than the outside diameter of the spindle, and it is supported entirely by two intermediate bearings placed between the spindle bearings, so that no belt strain whatever comes on the spindle. By this means it is possible to secure the necessary high speeds through the back gears without running the pulley on the spindle, thus eliminating a large part of the friction.

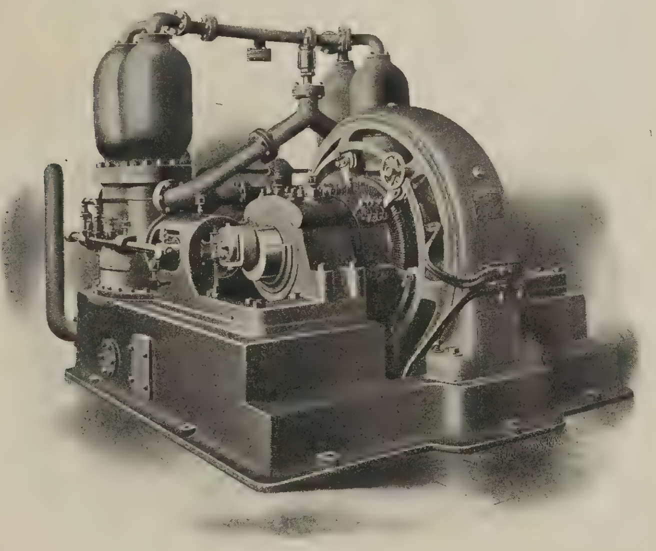
The end of the pulley sleeve has a positive clutch so that it can be engaged with a clutch which slides on the inside hub of the face gear. This clutch is operated by a lever handy to the operator. On the pulley sleeve are keyed two gears of different diameters into which either of a pair of sliding gears on the back gear shaft can be engaged. The ratios of these gears are: 3 to 1 and 9 to 1. The pulley on the sleeve is of large diameter and will take a much wider belt than formerly used on a cone pulley engine lathe. Special attention has been given to oiling, owing to the high speeds at which the lathe must run; deep oil wells are cast in the center of the bearings for the spindle and sleeve, which hold at least one pint of oil each. Ring oilers are used, but the rings have projections on them which scoop up the oil as they rotate. The other details of the lathe, aside from the head, are the same as those of the regular quick change gear lathe made by this company. The lathe is of 20-inch swing.

HIGH-SPEED ELECTRIC PUMP.

The operation of pumping machinery by electric motors, especially in mines, offers many obvious advantages, such as the centralization of the power plant, elasticity of extension of the system, high efficiency, small first cost and small expense for attendance.

Electric-driven pumps, however, have had one drawback, which, while not serious, had nevertheless to be taken into account. This was the necessity of toothed gearing, belts or other devices to transfer the power from the rapidly revolving motor shaft to the slow moving crank-shaft of the pump. Such devices added to the weight and size of the pumping unit and required either careful attention or frequent repairs. The use of toothed gearing on pumps in buildings is, moreover, objectionable on account of noise.

In the pump which we illustrate, the pump plungers are connected to cranks mounted directly upon the shaft of the motor. This pump has a capacity of about 250 gallons per minute against 1,000 feet head when running at a speed of about 300 revolutions. The pump has been so proportioned, however, that its mechanical efficiency is over 93 per cent., approximating closely that of the highest types of large steam pumping engines. The pump is of the duplex type; the cranks at the opposite ends of the motor-shaft being set at right angles to each other. The plungers are of the outside-packed pattern and the two plungers of each pump are connected by side rods. The plungers are 3½ inches in diameter and have a stroke of 5½ inches. In a carefully conducted test, the pump proved a success in every way, surpassing the expectations of the purchasers and even of the builders, and its operation is practically noiseless.



"Express" Electric Pump.

The pump and motor are mounted upon a rigid box-girder frame and occupy a relatively small space. While high-speed pumps have been constructed before, they have usually had mechanically-operated valves, but the designers of this pump have eliminated such complicated mechanisms entirely, apparently with beneficial results. The pumps are built by the Blake and Knowles Steam Pump Works, 114 Liberty Street, New York City, in capacities of from 200 to 4,000 gallons per minute and for heads varying from 100 to 2,000 feet. A test of Blake-Knowles, high-speed, duplex pump, 3½-inch plungers, 5½-inch stroke, direct-connected to a General Electric, 100 horse power, six-pole, 200-volt shunt motor, gave the following results:

		PUMP.			EFFICIENCIES.		
Revolutions per Minute.	Motor Input, Watts.	Gallons Delivered.	Pressure, Pounds.	Pump H. P.	Motor Pump	Motor Alone	Pump Alone
280	28,800	237	110	32.63	78 p.c.	86.5 p.c.	90.1 p.c.
280	40,600	237	215	48.94	82.2 p.c.	89 p.c.	92.36 p.c.
280	52,550	235	321	62.25	84.4 p.c.	90.1 p.c.	93.66 p.c.
280	60,200	234	425	74.53	84.3 p.c.	90.9 p.c.	92.74 p.c.
309	58,800	232	496	71.79	83.3 p.c.	....	....

OWEN MILLING MACHINE.

A new positive feed milling machine of the knee type has been placed on the market by the Owen Machine Tool Co., Springfield, O., and is here illustrated with two photographic views and a line drawing. The general specifications of the machine are as follows: The spindle is of crucible steel running in phosphor bronze boxes, and throughout the machine the plan has been followed of bushing the bearings for the various shafts and other rotating parts with bronze bushings, which insures durable wearing surfaces that may easily be replaced if occasion should require. The cone has four steps for a 3-inch belt, and with back gears which are covered; the machine has eight changes of speed. The overhang of the arm is 4 inches in diameter. The table has a working surface of 41 by 9¼ inches and can be lowered 17½ inches from the center of the spindle. The feed of the table is 25 inches and is positive and automatic. It can be engaged by simple movement of lever in front of swivel and can be disengaged by auxiliary lever releasing any feed instantly. The swivel can be clamped at any angle to 45 degrees. Sixteen changes of feed in geometrical progression vary from .003 inch to .084 inch per revolution of spindle back gear out; .020 inch to .500 inch back gear in. The absolute feeds per minute, countershaft running at 150 revolutions, are from ⅝ inch to 10¼ inches.

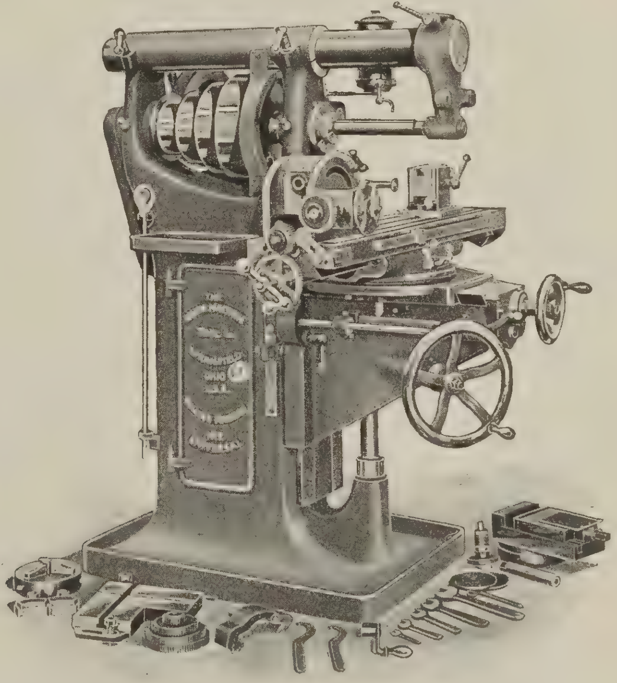


Fig. 1. Owen Milling Machine.

The details of the feed mechanism are shown in Fig. 3. The mechanism is driven by a chain and sprockets from the end of the milling machine spindle. Power is transmitted to shaft *B*, which, at one end, has the back gears *A* that may be thrown in or out of connection with shaft *B* by means of a handle convenient to the operator. These gears may be used either to change from a slow to a rapid feed, or *vice versa*; or they may be used to keep the feed constant, when the speed of the milling machine spindle is changed, by means of the main back gears. The feed back gears give the same ratio of reduction as the main back gears in order to accomplish this result.

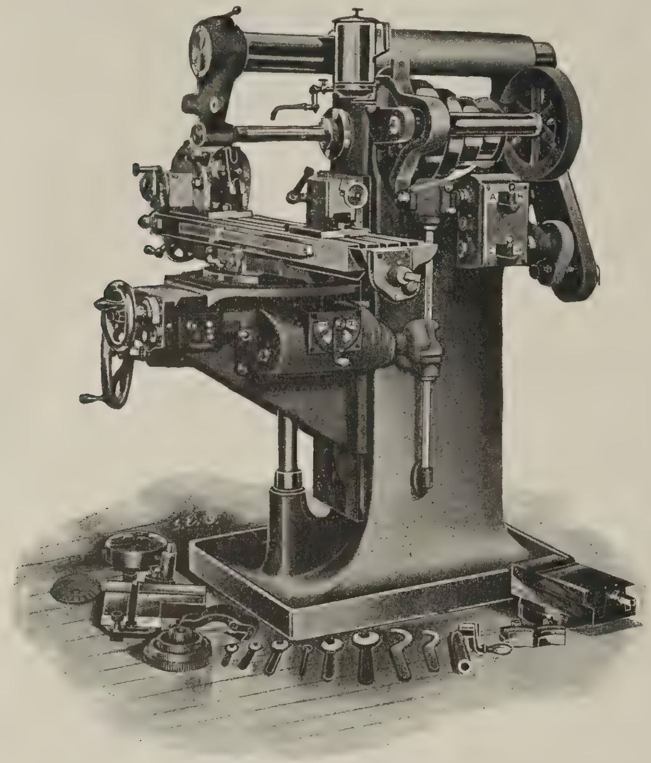
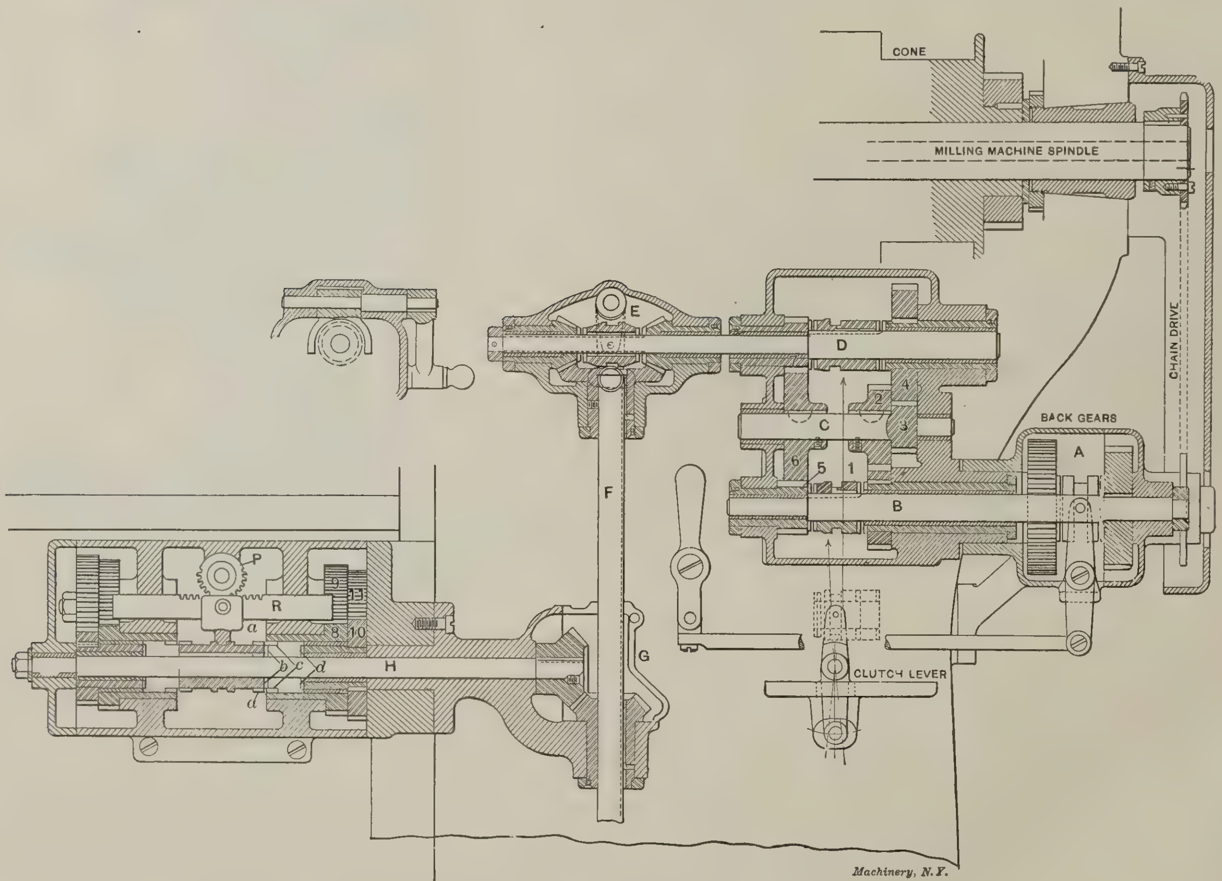


Fig. 2.



Machinery, N.Y.

Fig. 3. Details of Feed Mechanism of Owen Machine Tool Company's Milling Machine.

Motion is transmitted from shaft *B* to the milling machine table through two feed boxes, one of which is near the top of the base of the machine, as shown in Fig. 2, and the other attached to the knee. The first box contains shafts *C* and *D*, in addition to shaft *B* and two trains of gears which are numbered respectively 1 2 3 4 and 5 6 7. By means of the two clutches shown, either train of gears may be used which gives two feed changes.

The reversal of the feed is accomplished by the bevel gears and connecting clutch shown at *E*.

Power is transmitted to the feed box attached to the knee of the machine by the vertical splined shaft *F* and the bevel gears *G*, Fig. 3. These gears drive the horizontal shaft *H* on which is a clutch (containing new features of construction) which connects this shaft with any one of four trains of gears, giving at this point four changes of feeds. The clutch is operated by a handle attached to pinion *P* which gears with rack *R*. At the right will be noted pinion 10, attached to a sleeve which, at its left-hand end, has clutch teeth marked *d*. This pinion gears with pinion 11 and gives one speed. Pinion 8 has another set of clutch teeth marked *c*, and this pinion gears with pinion 9 and gives another speed change. The shifting part of the clutch contains teeth marked *a a*, which will mesh with the teeth *c* mentioned above by sliding the clutch to the right. By giving the clutch additional movement to the right, however, teeth *a* will travel by teeth *c* and allow the teeth marked *b*, on the extreme end of the clutch sleeve, to mesh with teeth *d* on pinion 10. At the other end of the clutch are similar arrangements for the two sets of gears shown.

This feed box, in connection with the other one, will give sixteen changes. The feed changes are all within easy reach of the operator and can be engaged when the machine is in motion without injury to the working parts, inasmuch as the clutches and pinions are of steel. The feeds are in geometrical progression.

WALKER UNIVERSAL GRINDING MACHINE.

The latest machine of the Walker Grinder Company, Worcester, Mass., is shown in the accompanying illustrations. It is a universal grinder, a comparatively light machine but of large capacity. It is designed primarily as a cutter grinder but can be used for miscellaneous grinding of all sorts of work, and with its various attachments it is believed by the manufacturers to be more completely universal in its scope than any grinder heretofore produced.

The fundamental principle of the machine is to start with a grinder primarily of the universal type and then to add such attachments as to adapt it to practically every kind of light grinding. The distinctive feature is that these attachments are extremely simple and fewer in number than are usually supplied with ordinary cutter and reamer grinders; and yet they are of such a nature that an unusual variety of work can be accomplished.

First in importance is the design of the head carrying the wheel spindle. This is shown in detail in Fig. 2. The head is supported by a sliding post, *A*, which can be raised and lowered by a screw, *B*. The wheel arbor is supported by a swiveling head, *C*, at the top of the column, and the arbor is belt-driven by the patented Walker system, which enables the head to be adjusted in any position up or down, or at any angle, without shifting the belt or without requiring any adjustment in the tension of the belt. The belt passes successively around pulleys *a*, *b*, *c*, and *d*; whence it goes up to the countershaft pulley. It will readily be seen that this arrangement allows a universal adjustment of the head without interfering with the belt drive.

It is a well-known principle that in taper grinding the contact point of the wheel must be in line with the axis of the work. The reading line *x*, therefore, is marked on the adjusting post of the head which, when set to coincide with the top of the housing, will bring the head and tail centers and wheel axis in the same horizontal plane. Another line marked *y*, Fig. 2, indicates the average height to raise the column in order to back off the teeth of cutters that are being ground. The tooth rest, *D*, Fig. 2, is clamped to the column, and is of such a height that when set so as to just rest on top of the grinder table its height will coincide with the line of centers. It is therefore extremely simple of adjustment. It is obvious that the tooth rest can be swung into any position to accommodate angular work.

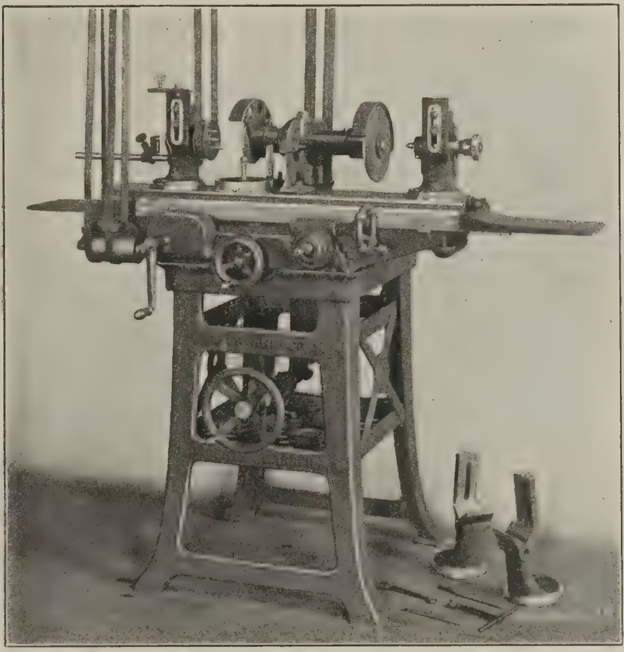


Fig. 1. Walker Universal Grinder.

The second most important feature of the machine is the use of so-called V-heads, shown in Fig. 3. Lugs, *N N*, serve to locate the heads in the T-slots of the table, and they are clamped in position by the nut *L* and bolt *M*, which is inclined so as to draw the head solidly against one side of the T-slot. When it is desired to swivel one of the heads it is placed on a graduated pedestal, not shown, and the bolt is changed to a vertical position. These heads are finished with accurately aligned V-grooves, in which may be clamped any cylindrical or, in fact, other shaped piece. The arrangement of the clamping device is evident from the sketch which shows how it can be used to hold taper pieces.

The first illustration shows the V-heads fitted with live and dead centers. These centers are simply fitted up in cylindrical bushings of a uniform outside diameter, and the bushings are clamped in the V-grooves. Fig. 4 shows the centers removed and a milling cutter arbor held in their place while the cutter is being ground. It indicates that the length of work held in this way is not restricted by the distance between centers.

In Fig. 5 is shown an end mill held in one of these heads by its taper shank, and it is to be noted that the clearance for the cutters is obtained by tilting the wheel arbor. This also shows a tooth rest clamped to the top of the head and also the back stop, against which the cutter arbor rests.

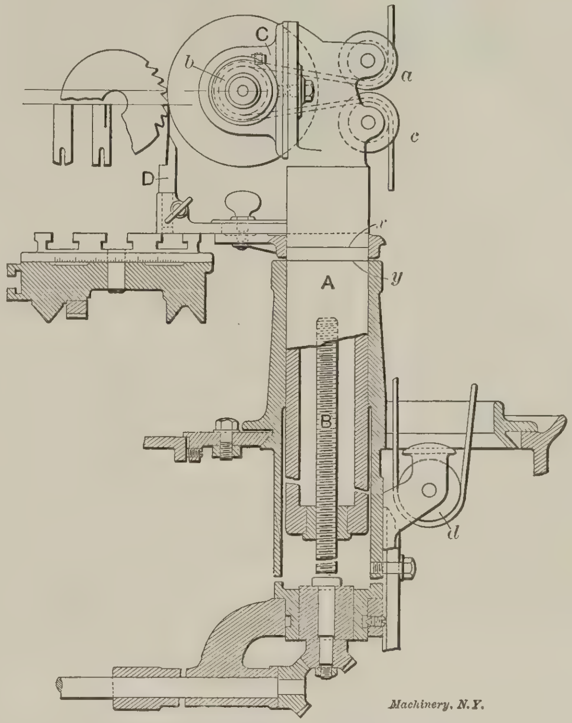


Fig. 2. Details of Column for Supporting Wheel Stand.

The illustrations thus far which show the universal features of the wheel head and the V-heads, will indicate to the mechanic how the wheel and the work may be brought into almost any relative position so that work of almost any shape can readily be ground, whether clearance is required or not. A very important feature of the swiveling wheel head is that it can be tilted to allow a thin beveled wheel to be used for grinding hand reamers without materially changing the size of the reamers. This is accomplished by grinding on the face of the teeth instead of on the outside diameter of the reamer.

Fig. 6 illustrates one of the uses of the universal chuck and independent spindle here shown, in place of the regular head center and faceplate, for holding a piece of work that cannot be centered in any other way. The independent spindle sleeve and the tail spindle sleeve being of exactly the same diameter the work is held in perfect alignment. In Fig. 7 the wheel arbor is swung around through an angle of 90 degrees and fitted with a lap for finishing a snap gage held by one of the V-heads. Fig. 8 is an example of face grinding where the cutter is supported by a draw-back face chuck, and Fig. 9 is an interesting view of grinding a vertical flat surface where it is desired also to get down into a corner. This is

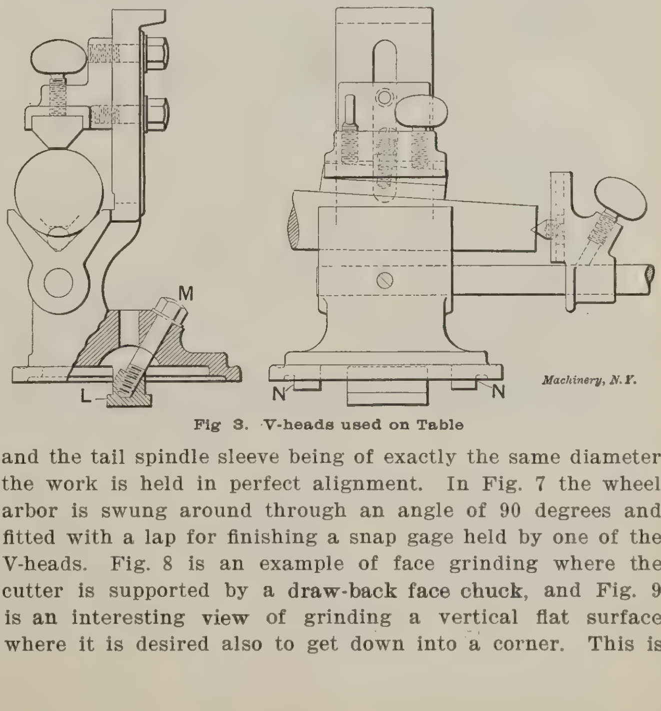


Fig 3. V-heads used on Table

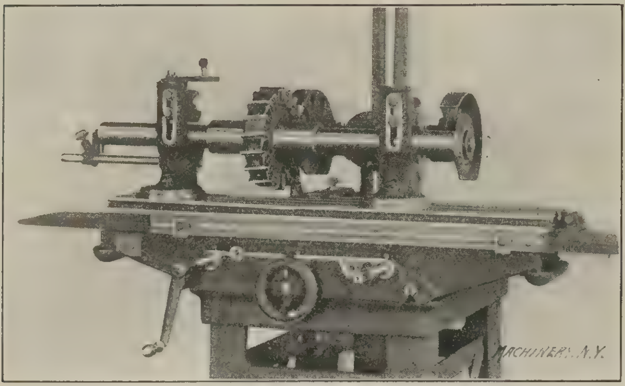


Fig. 4.

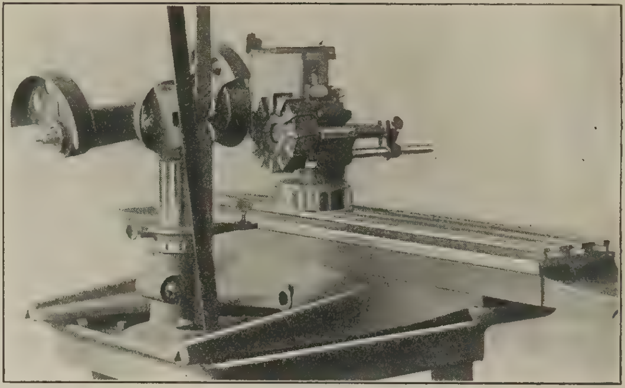


Fig. 5.

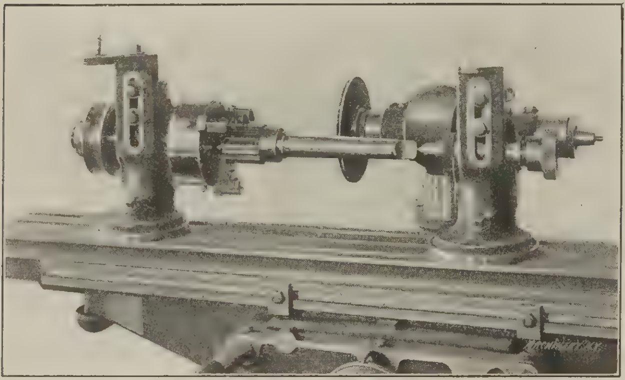


Fig. 6.

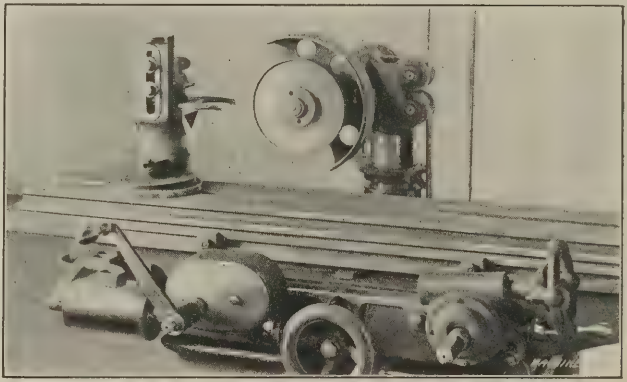


Fig. 7.

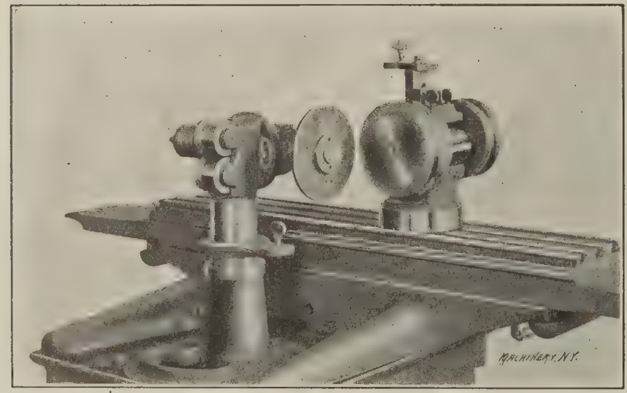


Fig. 8.

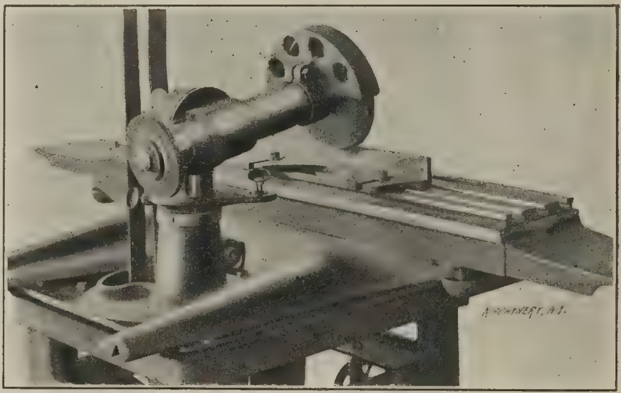


Fig. 9.

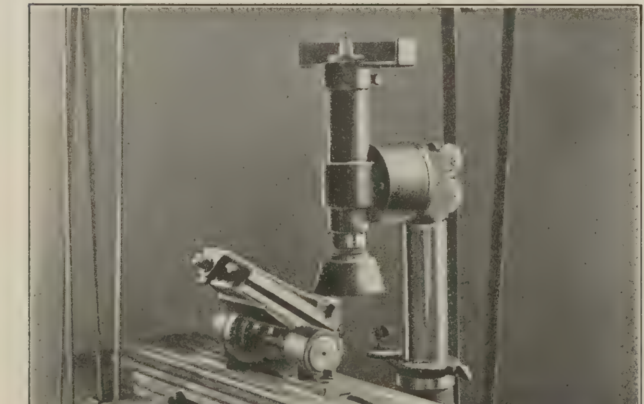


Fig. 10.

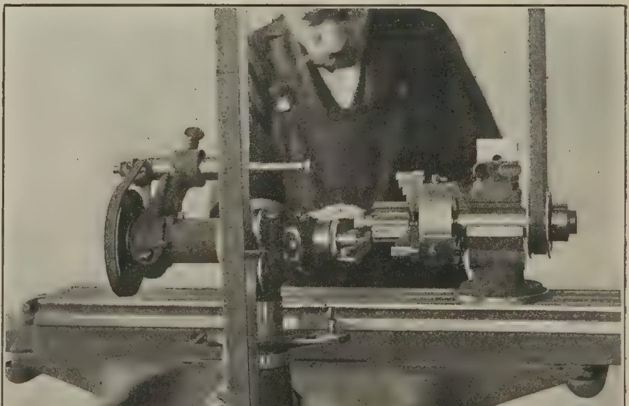


Fig. 11.

readily accomplished by tilting the wheel head slightly. Fig. 10 illustrates the extreme vertical adjustment of the grinding spindle, it being necessary in this case to insert an extension sleeve between the head and the post to obtain sufficient overhang for using the cupped emery wheel. This also shows the tilting vise fitted to the machine.

Fig. 11 illustrates the internal grinding fixture and one of its uses. This attachment fits on one end of the wheel head, on which it swivels, and is belt-driven. The small arbor is supported by a telescopic arm, and the central position of the small arbor is determined by a positive stop on the grinder head.

Perhaps as difficult a problem as any connected with the design of a universal grinder is the question of variable speeds. In this grinder special attention has been paid to the countershaft and a moderate-priced countershaft has been provided as the basis to which variable-speed devices can be attached at any time by the changing of a few parts. The principle of the variable-speed device is shown in the detail sketch, Fig. 12. Here the disks *A* and *B* are forced together by coil springs abutting on a collar *C*, which is fast to the shaft. This provides automatic action of these disks on the beveled edge belt, and it will be noticed that when the upper disks, at *D*, are closed, disks *A* and *B* will be forced open, and *vice versa*. The upper disks are mechanically operated by means of the pendant rod through bevel gears, and the horizontal screw *F*. When this screw is slackened the left-hand disk will move to the left, as will also the lower disk *B*, due to the action of its spring. This maintains the belt always in alignment but it will alternately approach and recede from the centers of the two shafts, and thus vary the speed of the driven one. The upper shaft is provided with an index dial *G*, indicating the proper size of grinding wheel to use for a given speed.

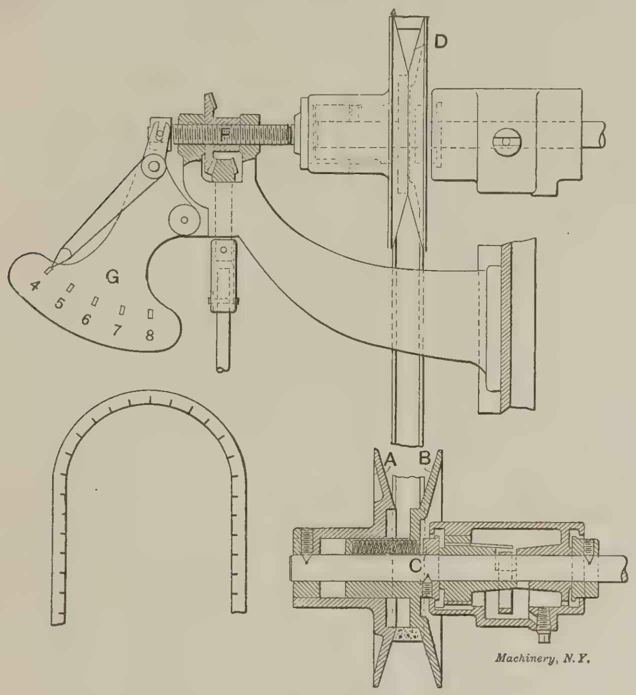
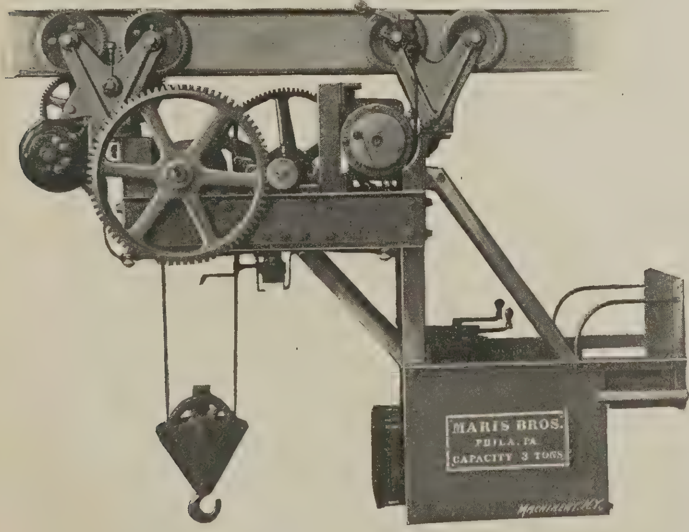


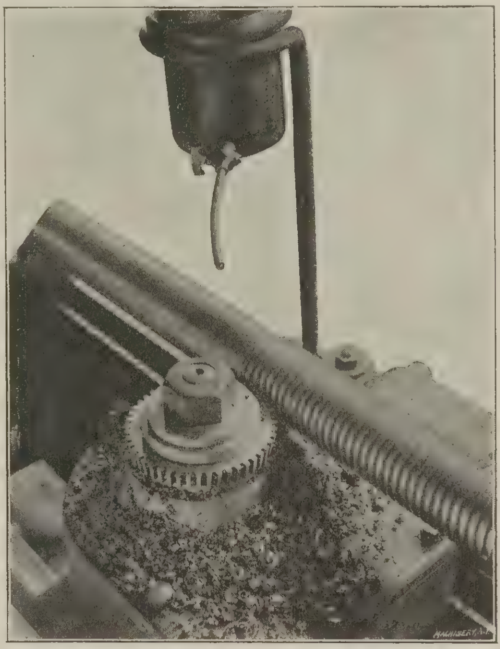
Fig. 12. Variable Speed Mechanism of Countershaft



Maris Traveling Hoist.

MARIS TRAVELING HOIST.

Maris Bros., Philadelphia, Pa., have brought out the new electric traveling hoist here shown, for rapid and therefore economical handling of materials. The half-tone shows this machine designed to run on the lower flange of I-beam track and having a cage for the operator. The whole machine is very compact, as shown by the following over-all dimensions of the three-ton size. Width 2 feet 7 inches, length 8 feet 4 inches, height bottom of track to bottom of cage 5 feet 1¼ inch, bottom of track to hook at highest point 3 feet 5 inches. The trucks are built either with swivel for curved track, or rigid for straight track. In cases where these machines have to cross switches or breaks in the tracks, as in transferring from a crane to a side run, there is an additional set of electrical contacts provided so as to avoid any dead point in running from one wire to the other. The hoist is by means of spur gears and wire rope, overrunning being prevented by an automatic cut-out. The cut-out only allows the block to travel to a set height when the switch is thrown and current reversed, allowing the load to be lowered, but not causing it to be hoisted until the switch is again set by the operator. No time is lost in depositing a load and there is no danger of overrunning on the hoist. The switch is in easy reach of the operator in the cage.



Newton Screw Thread Generating Machine

The cut-out is operated by the block in contact with a lever, and not by a screw or gears. This block-operated feature is important, as no matter how much the load rope may stretch or be shortened or lengthened with reference to the hoist, it will always throw the switch when the block is a fixed distance from the highest point.

These machines are made in various sizes and styles, to operate from a cage or from the floor.

NEWTON SCREW THREAD GENERATING MACHINE.

A tool has been designed by the Newton Machine Tool Works, Philadelphia, Pa., for generating and cutting screw threads. The cutting head of the machine is illustrated in the half-tone from the photograph shown herewith. The tool is in the form of a gear wheel having teeth of the proper shape to generate threads of the proper section in the screw to be cut. The teeth of the gear wheel are backed off and have clearance, to give cutting edges.

The tool revolves in a given proportion to the thread to be generated, and is geared to the correct relation to the lead of the thread being generated, and can be used for generating a thread of any pitch or number of leads with the exception of a square thread, which cannot be cut on this machine. The shaft on which the thread is to be generated, is driven at the ordinary cutting speed for this work, and the cutter is adjusted to take the full depth of thread in one cut.

The spindle to which the cutter is keyed obtains its rotative movement through a worm and wormwheel, which gives a smooth action to the cutter by change gearing.

This tool is not as yet perfected, but the screws that have been generated on this machine, have shown a remarkable saving in time, together with an exceptionally good screw or thread. The chips shown on the cutter head will give some idea of how the tool cuts.

* * *

It is sometimes found to be quite a convenience to have the bed of an engine lathe graduated in inches for quick setting of the tailstock. The graduations should be made with average length of centers in place and with the tailstock spindle drawn clear back into the tailstock. When a lathe is so marked a job can be measured on the floor and the tailstock set for it before lifting it into the machine.

* * *

FRESH FROM THE PRESS.

An Engineering Student's Notes, by J. Richards. 201 pages, 5½ x 7½ inches. No illustrations. Published by the Industrial Publishing Company, San Francisco, Cal. Price, $1.00.

This little book is not a collection of formulas and engineering data, in the usual sense of the terms, but is a series of notes and comments on things mechanical and otherwise, made by one who has traveled much and who sees things and thinks about them. Mr. Richards is the author of the "Notes from a Roving Contributor," published in Machinery a few years ago, and those readers who were fortunate enough to have read these delightful "thinks" will have some idea of what the present volume contains. For instance, the well-known Laxa waterwheel used for mine pumping on the Isle of Man, which was visited years ago by Mr. Richards as a technology student, traveling with his uncle, comes in for comment like this: "Just here is a chance for some mechanical moralizing. Suppose that wheel, instead of being constructed with arms and tie-rods as light as a bicycle, had been a heavy, cumbrous affair of the utilitarian kind, and had been set down in a pit in the usual manner with an old box penstock and chute; half the cost would have been saved, and what of that? No one would ever have gone to see the wheel. The cab fares extracted from affluent travelers will each vear fully pay the difference, and as a large share of the community consider money thus earned a gain of wealth, it is more, much more, legitimate and consistent than selling Pear's soap, and much else that is invented to play on human credulity, and extract shekels from the unwary."

A NEW DIRECTORY OF MACHINERY MANUFACTURERS.

The Mechanical Index. Over 1,000 pages, 6 x 8½ inches, bound in red cloth. Published by the Industrial Press, 66 West Broadway, New York.

The purchasing and selling departments of manufacturing concerns will be interested in The Mechanical Index, which, as its title indicates, is a complete directory of all manufacturers in the United States of mechanical tools and appliances, operated by steam, electricity, water, air, hand or foot power. An extremely valuable feature of the work is the completeness of its classification, there being in all over two thousand five hundred different classifications, covering every kind of machine tool, metal-working machinery, wood-working machinery, electrical appliance, steam appliance, railway appliance, agricultural machinery, textile machinery, mining machinery, hoisting and conveying machinery, foundry equipment, and a hundred other classes of mechanical appliances. The thoroughness of its classification is further indicated by the fact that there are thirty-eight different sub-headings for metal-working lathes alone. Each of these sub-headings is defined and carries an alphabetical list of manufacturers of that special kind of appliance. We consider it the most complete index to the machinery trades published, and it will prove a standard work of reference of great practical value to all manufacturers doing business with the trades covered.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

The F. Bissell Co., Toledo, O., manufacturers and jobbers of electrical supplies, are distributing their new Bulletin M29 on electrical measuring instruments.

The Link-Belt Engineering Co., Philadelphia, Pa. Booklet No. 39, 1904, describing the "Renold" silent chain gear for the smooth and noiseless driving of machinery.

The National Electric Co., Milwaukee, Wis. Bulletin No. 350 of stationary and portable motor-driven air compressors. Types "H" and "L" are here shown and described.

The O. K. Tool Holder Co., Shelton, Conn. Pamphlet treating of the O. K. patent tool holder, with assorted tools and fixtures. This holder was fully described in our last issue.

The Star Corundum Wheel Co., Ltd., Detroit, Mich. Pamphlet calling attention to the "Star" emery and corundum wheels. These are made of different degrees of hardness for the various classes of work.

The D. M. Steward Mfg. Co., Chattanooga, Tenn. Leaflets pertaining to the "Compo" crayons of their manufacture, made especially for marking freight cars, car trucks, etc., in a distinct and legible manner.

The Northern Electrical Mfg. Co., Madison, Wis. Leaflets Nos. 130 and 133 calling attention to the "Northern" motor for electric drive. These are shown driving a buzz saw, a swing cut-off saw, operating hoists and racks, etc.

The Pike Mfg. Co., Pike, N. H. Illustrated pocket catalogue of the oil stones manufactured. This is an interesting pamphlet; besides illustrations of the various kinds of oil stone, some useful instructions concerning their care and use, etc., appear.

Wickes Bros., 113-115 Cedar Street, New York. Leaflet illustrating the Wolverine center crank engine, the Wolverine plain and automatic vertical engine, and a plain vertical boiler and locomotive portable boiler of their manufacture.

The National-Acme Mfg. Co., Cleveland, O. Folder illustrating the "Acme Automatic" multiple spindle screw machine. This at present is built in six sizes, and two additional sizes—the No. 0, the smallest, and No. 6, the largest—will soon be ready.

The Goldschmidt Thermit Co., Wall Street Exchange Building, New York. Folder relative to "thermit" for welding iron and steel of any section, trolley rails, girders, shafts, sternposts, etc. An article on "thermit" and its uses was published in the March, 1903, issue of Machinery.

The Garvin Machine Co., New York. Catalogue "G" of metal working machine tools. This book presents the agency goods carried in stock by the company, contains 274 pages, and illustrates drill presses, engine lathes, planers, shapers, punch presses and shears, and grinding and polishing machinery.

The Thos. H. Dallett Co., Philadelphia, Pa. Illustrated catalogue of portable drilling machines and boiler shell drills. These drilling machines, which are built in various sizes, are here fully illustrated and described and specifications given. A few hand drills and a pneumatic hose coupling are also shown.

The Carlyle Johnson Machine Co., Hartford, Conn. Pamphlet descriptive of the Johnson friction clutches for countershafts, also for use with line shafts—saving power, belting and pulleys. This clutch is simple in construction and smooth running, and the working parts are entirely covered, being thus kept free from dirt.

The Niles-Bement-Pond Co., New York. July, 1904, number of the *Progress Reporter*, to be issued every few weeks with a view to keep readers informed as to the new machines and devices which they are bringing out. This number contains illustrations of the heavy machine tools built by the several firms constituting this company.

The Hisey-Wolf Machine Co., Cincinnati, O. 1904 catalogue of the "Hisey" portable electrically-driven grinders and drills. The different types of these machines are here shown and described and illustrations of the uses to which they can be put are given. A list of the users of these tools also appears, among which we note the names of prominent manufacturers.

The Hoggson & Pettis Mfg. Co., New Haven, Conn. Catalogue 7 illustrating the "Sweetland" chuck. The "Sweetland" combination, universal, independent, and geared scroll chucks are here shown in different styles. Special chucks for various lines of work are also made. The "Porter" belt tightener, for clamping together securely the ends of large belts is also shown.

The B. F. Barnes Co., Rockford, Ill. Illustrated catalogue, 1904, of machine tools. These include upright drills, lathes, water tool grinders, etc. The different sizes of drills are shown, in particular a battery of six 20-inch drills, two new sliding head drills, various sizes of gang drills and the two-spindle manufacturers' drill with automatic revolving chuck, described in our July number.

The Massachusetts Tool Co., Greenfield, Mass. No. 4 catalogue of precision tools. This illustrates and briefly describes calipers, dividers, gages, drill and reamer holders, micrometers, levels, protractors, etc.—in fact all those tools necessary to the machinist engaged in fine and accurate work. This catalogue supersedes all previous editions and contains quite a number of new tools and devices.

The Cleveland Twist Drill Co., Cleveland, O. 1904 catalogue, superseding all previous editions. This catalogue illustrates the twist drills, reamers, taps, mills, cutters, etc., manufactured, and a very complete index appears; also some valuable tables and other information on the subject of drills, etc. They call special attention to their turret lathe and screw machine tools, pages 72 to 74. A copy of this catalogue will be mailed to any one interested, upon request.

Henry R. Worthington, New York. Catalogue W-50 of Worthington centrifugal pumps. These are of the turbine, volute and conoidal types. Each of these types is here described and illustrated, the different sizes of each being shown. These pumps may be driven by electric motor power. The front page of the catalogue shows a view of the new works of the company, containing 18 acres of floor space, and being erected at Harrison, N. J.

The Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York. Catalogue No. 35, of air compressors. This is simply the "Advance Sheets" of their catalogue No. 36 now in course of preparation, but it illustrates the different standard types and sizes of air compressors manufactured, and is complete in itself. The company state that their aim has been to present cuts of the standard types and prominent installations, with comments upon each, brief and to the point. The half-tone reproductions and press work are very fine, and there is a good view of their new works at Phillipsburg, N. J.

The Ingersoll-Sergeant Drill Co., New York. Attractive pamphlet issued by the pneumatic tool department of this company, containing a full description and excellent illustrations of the construction of the Haeseler "Axial Valve" hammer. Reference is also made as to the scope of a recent decision of the Supreme Court bearing on patented features of pneumatic hammer handles. These hammers are for chipping, calking, flue-beading, riveting, etc., and are manufactured in a variety of sizes. The MacDonald rivet heating forge, and piston drills, yoke and jam riveters and other tools are also shown here.

The Garry Iron and Steel Co., Cleveland, O., report the following orders: One three-motor special electric Gantry transfer crane, of entirely new design, for the Raritan Copper Works, Perth Amboy; one of their latest improved three-ton pneumatic pit jacks, for the Indianapolis & Cincinnati Traction Co.; the automatic pneumatic mechanism for operating models of Climax and Tower couplers at the exhibit of the National Malleable Casting Co. at St. Louis, also an automatic pneumatic turntable for the same company; one four-hook overhead crane for the Western Electric Co.; one two-part clam-shell bucket for the Lake Sand and Gravel Co., etc.

MANUFACTURERS' NOTES.

The Cincinnati Milling Machine Co., Cincinnati, O., have received the order of the Canadian Westinghouse Electric & Mfg. Co., Hamilton, Ontario, Canada, for eleven milling machines and two cutter grinders.

The Crocker-Wheeler Co., Ampere, N. J., announce that they have taken steps to give their clients expert advice upon the latest ideas and results in shop practice, also engineering advice upon the design and installation of electrical apparatus. For this purpose they have retained the firm of Dodge & Day, Philadelphia, modernizing engineers.

The Columbus Machine Co., Columbus, O., have opened an office in Cincinnati, O., at 227 West Fifth Street, where they will carry a stock of engines. The office will be in charge of Mr. Van Dusen, who is well-known to the gasoline engine trade. Mr. Van Dusen will be pleased to receive his old customers and friends, and any prospective buyers of gas engines, as he will have engines in operation to show the merits of the Columbus.

The Northern Electrical Mfg. Co., Madison, Wis., have called our attention to the fact that three of the new tools which we illustrated in our July number are operated with the "Northern" single voltage variable-speed motor. These are the Gisholt boring mill, the National Machinery Co.'s bolt cutter and the Merrell pipe cutting machine, all described in the "New Tools of the Month" department of the above-named issue.

Reynolds & Gordon is the name of a new firm just started in Brooklyn, N. Y., corner Vanderbilt and East Third Streets. Mr. J. R. Gordon, of the firm, has had an extended experience in fine tool work and has been a frequent and valued contributor to Machinery upon tool making. The work of the new firm is to be largely in the direction of fine tool, die and machine work, and attention will also be given to the development of inventions, the making of models, etc.

August Mietz, New York, manufacturer of the Mietz & Weiss oil and gas engine, has recently installed a 10-horse power "M. & W." engine air compressor in the new building at 42d Street and Park avenue, this city, now in course of construction. The air compressor is an 8 x 8, giving 70 cubic feet of free air per minute against 80 pounds pressure. It was installed by Ritchie, Brown & Donnelly, contractors, to furnish air for their pneumatic tools.

The Crocker-Wheeler Co., Ampere, N. J., announce that by arrangement with Brown, Boveri & Co., Switzerland, electrical engineers, they have secured their alternating current designs, patents and rights

BROWN & SHARPE MFG. CO.

PROVIDENCE, R.I., U.S.A.

GEAR CUTTERS

FROM

ORIGINAL CURVES

to manufacture in America, retaining the Swiss company as consulting engineers. They inform us that they are putting on the market alternating-current generators, transformers and accessories of perfect design and construction, adapted to American practice, and opportunities to bid on this apparatus are invited.

The Rand Drill Co., 128 B'way, New York, have been awarded the contract for furnishing two large compressors to be used in the Central Air Power Plant, eighteen miles below Sault Ste. Marie. They will supply air to operate 25 Little Giant rock drills, 4 three-ton cableways and 4 large water pumps. Their combined capacity is 6,600 cubic feet of free air per minute. The work in hand is for constructing and dredging a two-mile channel in the Soo River, wide and deep enough for the navigation of large vessels.

The Hartford Blower Co., Inc., 120 Suffield Street, Hartford, Conn., are rushed with orders, being obliged to work overtime and having increased their plant and the number of their employees. Among large orders lately received are: Three 160-inch fans and 24 heaters for the Eastern Tanners' Glue Co., two large "Hartford" mechanical dust-collecting systems for Wm. A. Rogers, Ltd.; 10 large heaters for the Hillman Tobacco Curer Co., and a "Hartford" mechanical dust-collecting system for the Elm City Lumber Co.

The Marvin & Casler Co., Canastota, N. Y., is the new name of the concern formerly known as Marvin & Casler, engaged in the manufacture of machinery. The directors for the ensuing year are H. N. Marvin, president; H. Casler, treasurer, and L. R. Cooper, secretary and manager. Their factory has been enlarged and new machinery added, increasing their facilities. They state that they are especially equipped for the manufacture of machines in quantities with intercchangeable parts.

Robert Grimshaw, Wambuchenstrasse 9, Hanover, Germany, has sent us a sample of the 45-degree "Kavalier" perspective sketch cards (legally protected) for machine shops, patent agents, etc., which he has brought out. For those preferring the 120-degree isometric perspective (the measurements of which are the same at the principal axes), he offers an isometric linear card (legally protected also). For beginners, those studying and requiring sketch cards, etc., he has an isometric 145-degree sketch paper, with printed text.

The Joseph Dixon Crucible Co., Jersey City, N. J., are sending out a card calling attention to the difficulty of properly lubricating the air cylinders of air compressors with oil, and the danger attendant to the use of low flash-point lubricating oil; a number of bad receiver explosions have been traced to the use of such oils, which generate explosive vapors. With graphite the cutting and grinding of the cylinders is stopped and the supply of oil may be greatly reduced, which is desirable even if high-grade oil is employed.

The Hart Mfg. Co., Cleveland, O., inform us that their representative at Yokohama, Japan, has been much annoyed recently by postal requests for catalogues received from the Sumidayen Co., 17 Tatami Street, Tokyo. This concern is engaged in the collection of old books, postage stamps, etc., and they make it a practice to secure catalogues from American manufacturers for the purpose of selling same, in which it appears they have been quite successful. The Hart Company request us to publish this item as a warning to manufacturing concerns.

The Canadian Rand Drill Co., Sherbrooke, Que., recently closed with the Canadian Westinghouse Co., of Hamilton, Ont., for the installation of a "Rand-Corliss" compound, power driven, air compressor, to be installed in their new plant. This machine is designed to furnish air for the various pneumatic appliances throughout the works and is to be driven by a Westinghouse motor through a Morse chain drive. The International Coal & Coke Co., Coleman, Alberta, have just placed an order with the Canadian Rand Drill Co. for a 300 horse power, steam driven, Rand duplex compressor of the very latest type.

Manning, Maxwell & Moore, New York, have secured a large order amounting to between $150,000 and $160,000 worth of tools from the Illinois Central Railroad, to be shipped to the various shops along their lines. The order consists of a full line of railroad tools. They have also secured the following orders: All the electric traveling cranes required for the various shops of the Illinois Central Railroad; a large order from one of the Government powder depots; a number of orders from various navy yards on the eastern and Pacific coasts; a large order for the shops of the Central Railroad of New Jersey; and several orders for an assortment of machine tools going to some of the Western railroads.

The Wilmarth & Morman Co., Grand Rapids, Mich., report the receipt of the following orders recently, for their "New Yankee" drill grinders: Louisville & Nashville R. R. Shops, Louisville, Ky.; Woodmanse Mfg. Co., Freeport, Ill.; Tabasco-Chiapas Trading and Transportation Co., Tabasco, Mex.; Diamond Chair Co., Chico, Cal.; Morrison Mfg. Co., Fort Madison, Ia.; Rome Brass and Copper Co., Rome, N. Y.; Duluth St. Ry. Co., Duluth, Minn.; Scott & Oliver Mfg. Co., Knoxville, Tenn.; Hersey Mfg. Co., Boston, Mass.; Redwoods Mfg. Co., Black Diamond, Cal.; Pittsburg Valve, Fdy. and Construction Co., Pittsburg, Pa.; Atlantic Coast Line R. R. Co., Wilmington, N. C.; J. F. W. Dorman Co., Baltimore, Md.; U. S. Navy Yard (League Island), Pa.; Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y. Also one grinder to Holland, two to Canada, three to Russia, etc.

SUMMARY OF NEW TOOLS, CATALOGUES, ETC.

IN THIS NUMBER.

MACHINERY describes in each number more new tools and appliances than any other mechanical paper, and a glance over this column will enable the reader to pick out what is of special interest to him.

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Marking Crayons: D. M. Steward Mfg. Co., Chattanooga, Tenn.	
Electric Motors: Northern Electric Mfg. Co., Madison, Wis.	
Oilstones: Pike Mfg. Co., Pike, N. H.	
Engines and Boilers: Wickes Bros., New York	
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Machine Tools: Garvin Mche. Co., New York	
Drilling Machines: Thos. H. Dallett Co., Philadelphia, Pa.	
Friction Clutches: Carlyle Johnson Mche. Co., Hartford, Conn.	
Electric-Driven Grinders and Drills: Hisey-Wolf Mche. Co., Cincinnati, O.	
Chucks: Hoggson & Pettis Mfg. Co., New Haven, Conn.	
Machine Tools: B. F. Barnes Co., Rockford, Ill.	
Precision Tools: Massachusetts Tool Co., Greenfield, Mass.	
Twist Drills, Reamers, etc.: Cleveland Twist Drill Co., Cleveland, O.	
Centrifugal Pumps: Henry R. Worthington, New York	
Pneumatic Hammers: Ingersoll-Sergeant Drill Co., New York	
Air Compressors: Ingersoll-Sergeant Drill Co., New York	

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.
The money should be sent with the order.

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THE HAWKINS' ENGINEERS' LIBRARY is still supplied to the readers of Machinery on the easy monthly payment plan. They are the most helpful books published for engineers and firemen. Send postal for Hawkins' catalog. THEO. AUDEL & CO., 63 Fifth Avenue, New York City.

WANTED.—A man to revise technical manuscript. Qualifications: Ability to write good English; machine shop experience; two years' technical education or equivalent. State experience and salary desired. Address Editor of Machinery, 66 W. Broadway, New York.

WANTED.—A first-class man as superintendent and managing director of a machinery and foundry works, who can become financially interested, must be thoroughly experienced in machine tools, presses and special machinery. Address C. H. T., care Machinery, 66 West Broadway, New York.

WANTED.—Agents, machinists, tool makers, increase your salary. Sell Saunders' enlarged Hand Book for Practical Mechanics. A pocket manual guaranteed to fill the bill as a ready reference and to contain more rules, shop kinks, than all the other mechanical books bound together in one volume. Secrets, from note books of best mechanics in the country, will figure out by simple arithmetic problems you run up against every day in the shop. Price, postpaid, $1.00 in cloth, $1.25 in leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase Street, Boston, Mass.

WANTED.—A machinist in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. SMITH, Columbia, Pa.

WANTED.—Complete equipment of machinery for a machine shop. Address with particulars—"NEW SHOP," care Machinery, 66 W. Broadway, New York.

WANTED.—Copies of numbers 7 and 8 of Machinery, Volume 9. Address, with price. THE INDUSTRIAL PRESS, 66 West Broadway, New York.

WANTED.—First-class superintendent (with or without capital) for a foundry and machine shop employing eighty men. Address "A," care Machinery, 66 W. Broadway, New York.

WANTED.—Good salesmen, must be mechanical engineers; good proposition to first-class men. Address HAWLEY DOWN DRAFT FURNACE CO., Chicago, Ill.

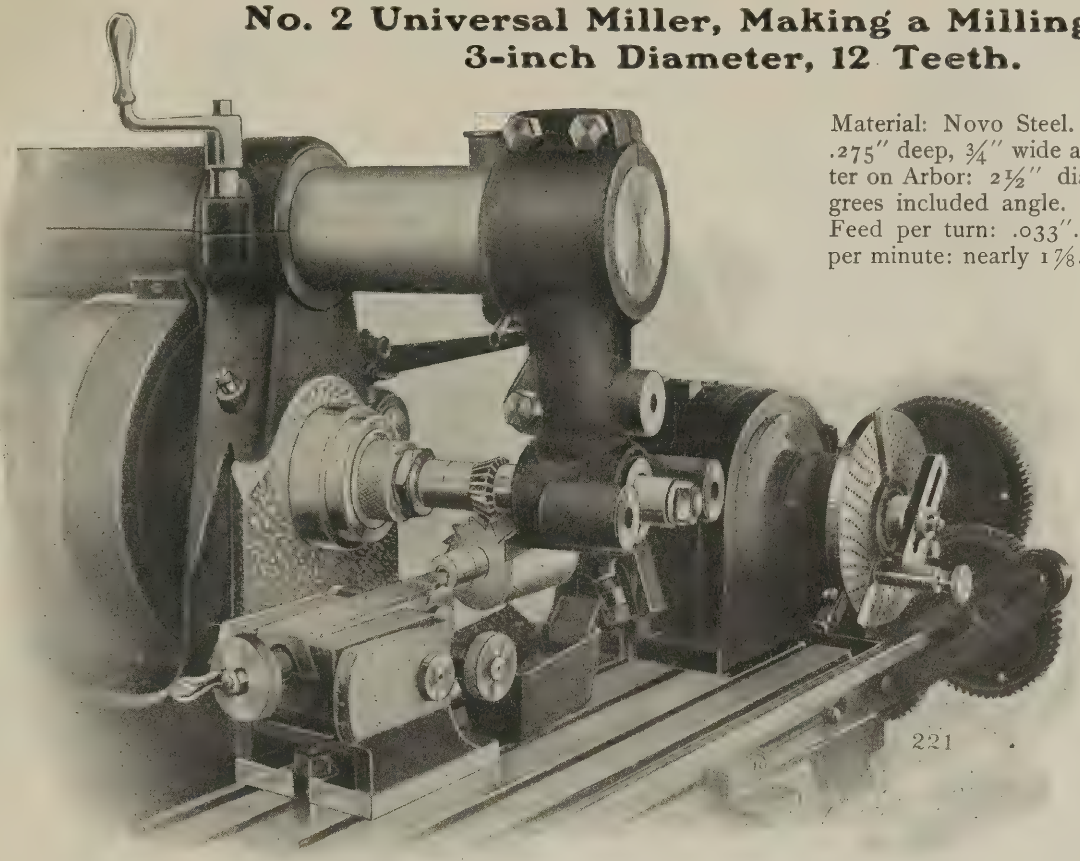
WANTED.—Master mechanic who thoroughly understands sheet metal ware machinery and dies of all kinds, such as are usually used in a large tin and enameled ware factory. State experience, age, wages expected and give references. Applications strictly confidential. Address "A. D.," care Machinery, 66 West Broadway, New York.

WANTED.—One machinist or draftsman in each shop to have a free copy of this new course of instruction in Gasoline Engines, Motor Carriages, Boat Machinery, and Aerial Motors. Just out. The largest and most complete publication of its kind in the world. Including twenty-eight sheets of blue prints, free consultation, sketching and expert advice on your own problems. This is your opportunity. Prospectus free to any one. Send for it. S. M. HOWELL, M. E., Zanesville, Ohio.

WANTED.—Positions for reliable engineers, draftsmen, foremen and superintendents. Good men wanted to register. CLEVELAND ENGINEERING AGENCY, Station B, Cleveland, Ohio.

WANTED.—Superintendent to take charge of the manufacture of gas engines on a large scale for a company just commencing the manufacture of gas engines; must be thoroughly familiar with the details of manufacturing gas engines in every respect; must have thorough, practical experience on gas engines; of good character; good organizer. Must have tact and ability to handle men to the very best advantage; technical education not absolutely necessary; need not be a designer. Best of references must be furnished. To the right man a good position. Address GAS ENGINES, care Machinery, 66 W. Broadway, New York.

No. 2 Universal Miller, Making a Milling Cutter 3-inch Diameter, 12 Teeth.



Material: Novo Steel. Size of Cut: .275″ deep, ¾″ wide at the top. Cutter on Arbor: 2½″ diameter, 80 degrees included angle. R. P. M.: 56. Feed per turn: .033″. Table travel per minute: nearly 1⅞.

Does Your Tool Room Pay?

The chances are, that it doesn't—there are many such. The fault is usually in the tools. You cannot expect your toolmaker to get "modern" results out of a miller that was bought 12 or 15 years ago and is "still good", nor out of a newer machine of the "cheaper-but-just-as-good" kind. Try it yourself. This illustration shows modern practice. It is one of our every day jobs, and shows the sort of work for which our No. 2 Universal Miller is especially adapted. It does this quietly without any tendency to chatter, finishing each tooth at a single, smooth, clean cut. If you have a stiff machine with a powerful Dividing Head like the "Cincinnati", such results are easily obtained. Let us tell you more about it.

1904 Louisiana Purchase Exposition.—Our electrically-driven Millers may be seen in the exhibits of the Westinghouse Electric & Mfg. Co., Northern Electrical Mfg. Co., Western Electric Co.

We will be pleased to submit time estimates with suggestions for milling your work.

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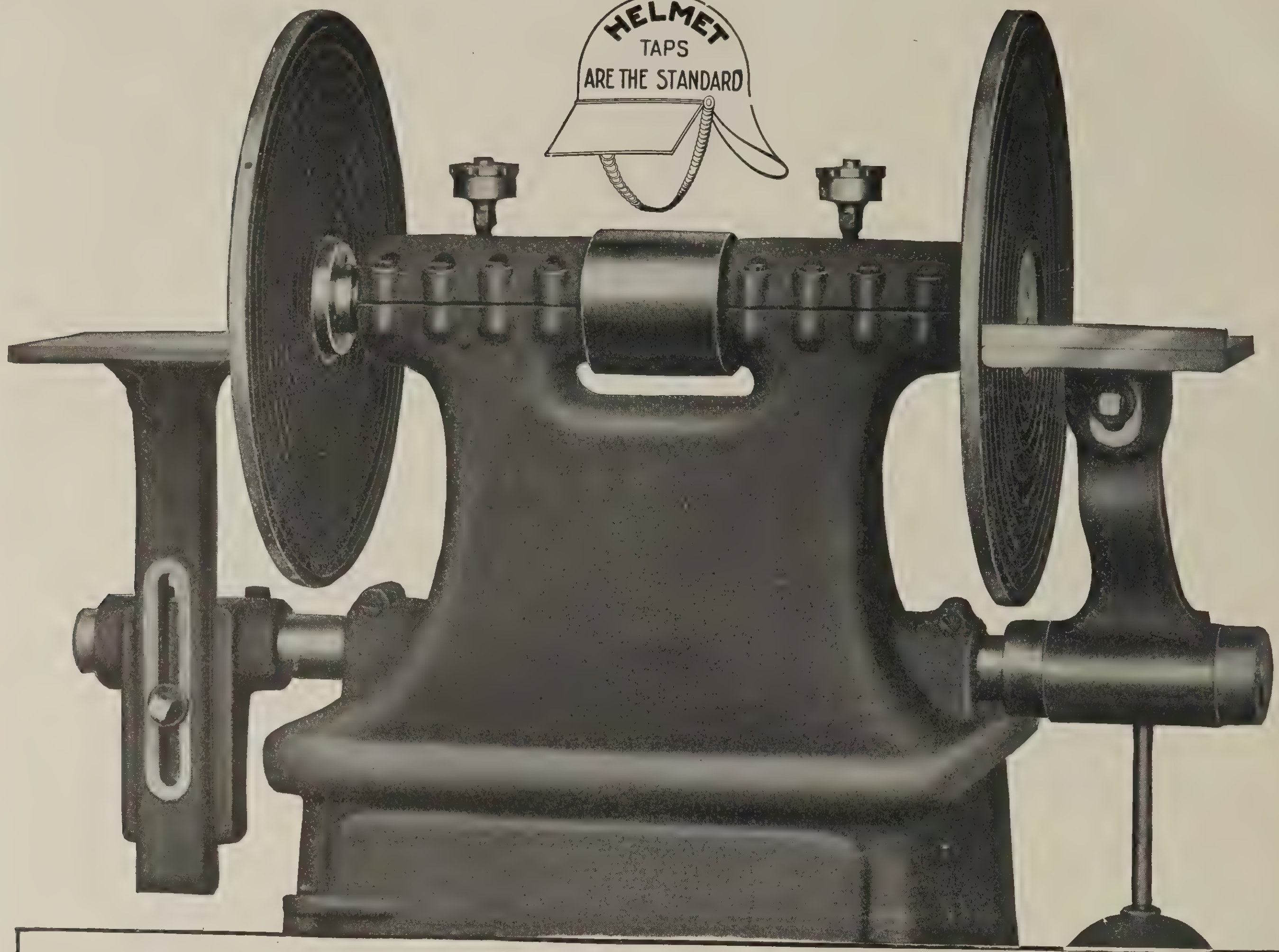

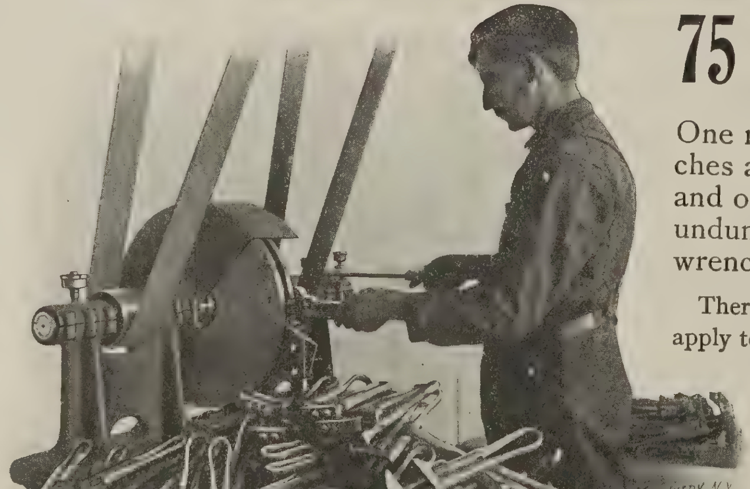
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The Gardner Grinder with special grooved discs saves 50% on all flat grinding. Send us a sample of your work and let us try it on the Gardner; we will finish and return it free of charge, marking the time required, composition used on spiral circle and the size machine on which it was done.

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MACHINERY, N.Y.

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Numbered for purposes of identification and in any correspondence concerning copies please refer to these numbers, being sure to use the prefix "M" so we may properly credit "MACHINERY" with advertising returns.

Beadings and Borders, Brass	M150
Benches, Carpenters, etc	M184
Blocks, Shelf	M102
Bolts, Stove	M 64
Box Trimmings	M118
Brushes, Glue and Varnish	M 93
Builders' Hardware	M145
Burrs and Rivets	M229
Butts, Wrought Steel and Brass (lists)	M219
Cabinet Hardware	M151
Cabinet Trimmings (fancy)	M192
Card Frame Pulls	M172
Carpet Layers' Tools	M132
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Chair Seats, Wood Perforated	M201
Chair and Stool Screws and Spiders	M108
Chests, Tool	M230
Clamps, Hand Screw, etc	M185
Clay Modeling and Plaster Carving Tools	M212
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Drills, Star, For Brick, etc	M 56
Emery Wheel Dressers	M148
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Sheaves and Rail for Sliding Doors	M 70
Splitting Paper (Sandpaper)	M134
Tacks, Twine, etc.	M 52
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Tools, Clay Modeling and Plaster Carving	M212
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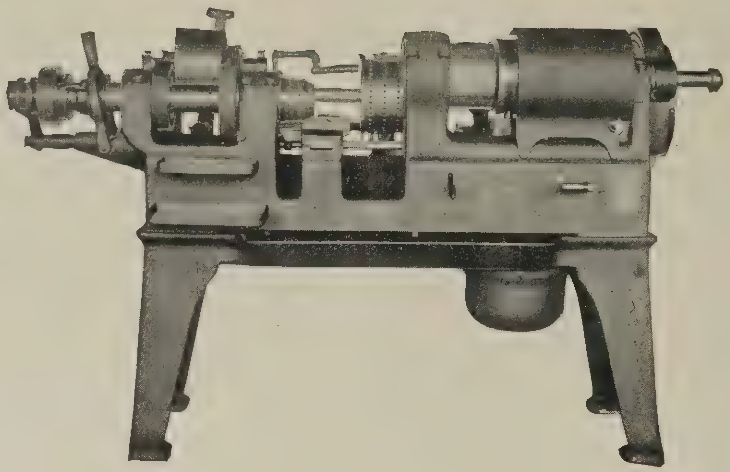
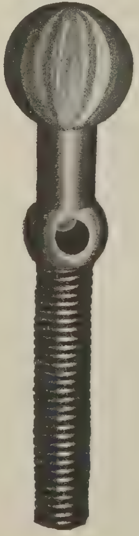
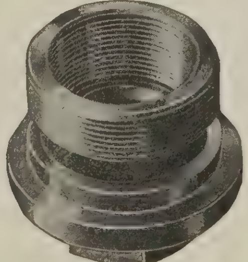


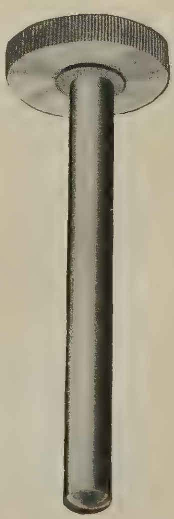
It would take so long to enumerate all that *can* be accomplished on a Cleveland Automatic Screw Machine that the simpler way would be to state what *can't* be done—

Suffice it to say the "Cleveland" will produce automatically pieces of all shapes and sizes from castings, forgings or the bar and effect a saving in cost ranging from 200 to 500 per cent. That the "Cleveland" is built for all kinds of work from the simplest to the most complicated, to handle almost any material, and to save an incalculable amount of time, labor and trouble. If you are interested in producing multiple parts rapidly, accurately and economically send us samples or blueprints of the work you are doing; we will estimate the cost of turning it out on our machines and return the sample with our figures—it will cost you nothing and may mean a good deal for the future.

We show a few examples of work done on Cleveland Automatics.







The Cleveland Automatic Machine Company

CLEVELAND, OHIO, U. S. A.

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CANADIAN REPRESENTATIVE—H. W. Petrie, Toronto, Ont.
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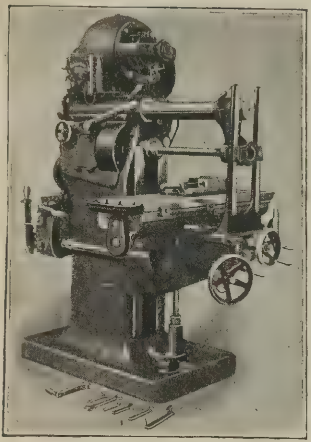
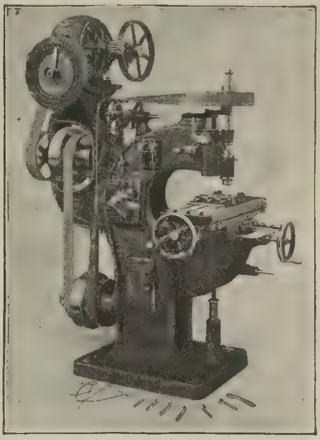
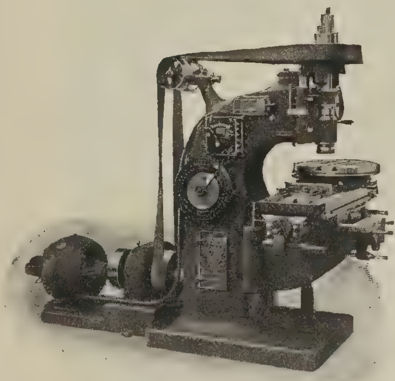
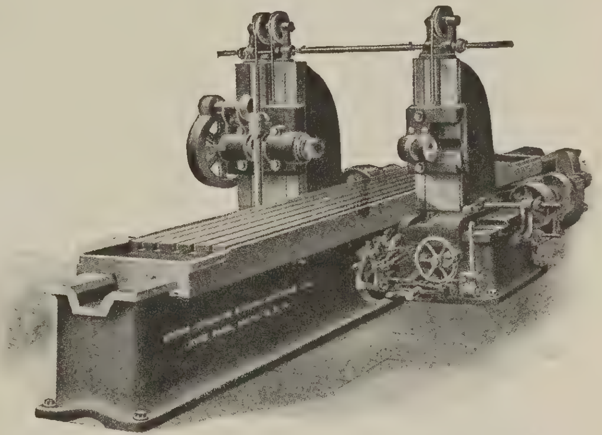
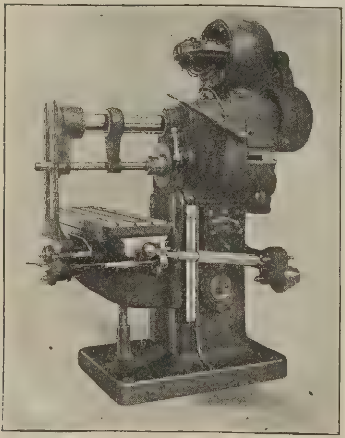
Block 13, Machinery Hall, Louisiana Purchase Exposition comprising machines shown herewith, also cutters for use with same

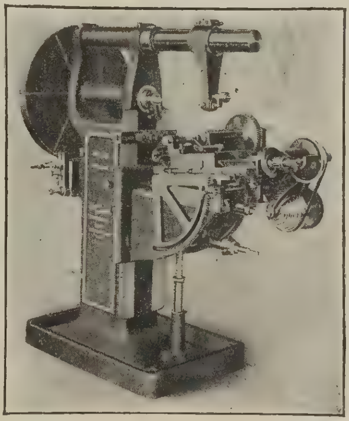

No. 3 Gear Feed
Plain Milling Machine

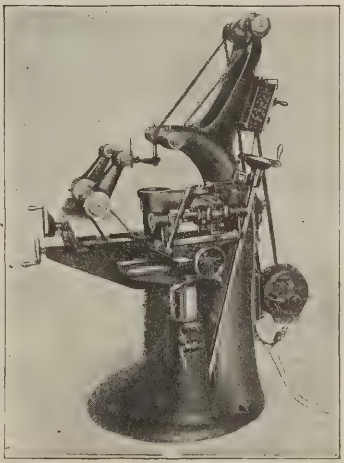

No. 3 Vertical
Milling Machine


No. 5-B Vertical Milling Machine


26″ x 32″ x 10 ft. Planer-type Milling Machine


No. 5-B
Plain Milling Machine


36″
Automatic Gear Cutter


No. 1—14″
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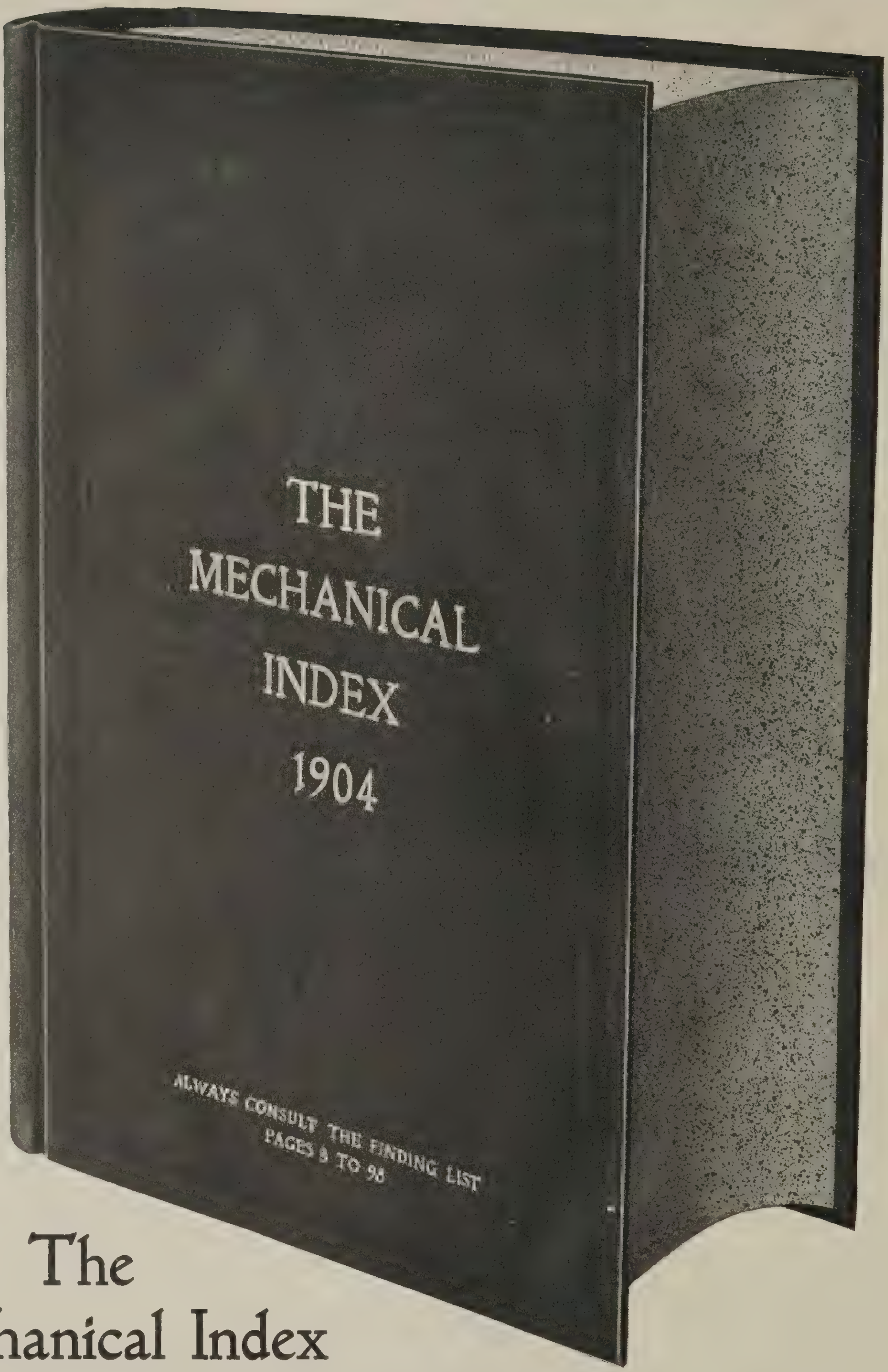

The
Mechanical Index

not only includes a complete list of all manufacturers of mechanical appliances in the United States, but gives a concise explanation of the use for which each appliance is intended. It does not include branch offices, nor agencies of manufacturers, nor dealers. Gives the headquarters address of every manufacturer under exactly the right heading, and classifies the whole so as to save the time of its users.

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